BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE DOMINIONS, COLONIES AND INDIA

PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE, ASSISTED BY OTHER CONTRIBUTORS

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THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire: (i) by arranging comprehensive exhibitions of natural products, especially of the Dominions, Colonies and India; and (ii) by providing for their investigation, and for the collection and dissémination of scientific, technical and commercial information relating to raw materials.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (afterwards King Edward VII) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Dominions, Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture and the Board of Trade.

Under a subsequent arrangement between the Departments concerned, the Colonial Office became chiefly concerned with the management of the Imperial Institute.

In April 1916 the Imperial Institute (Management) Act was passed transferring the property and management of the Imperial Institute to the Secretary of State for the Colonies. The Act provides for the appointment of an Executive Council consisting of twenty-five members, nominated by the Board of Trade, the Secretary of State for India (two each), the President of the Board of Agriculture and Fisheries, the Government of India, the Governments of the several Dominions (one each), and the Secretary of State for the Colonies (fourteen). A list of the present members of the Council is given on pp. xi and xii, and a list of the various Committees which have been appointed on pp. xii-xvii.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology and mineralogy, and in certain branches of technology, in their relation to commerce and to the industrial utilisation of raw materials.

The following are the principal sections of the Institute and departments of its work.

Scientific and Technical Research Department: Investigations.—The technical laboratories and workrooms of this Department were established in order to provide for the investigation of new or little-known raw materials from the Dominions, Colonies and India, and of known products from new sources, with a view to their utilisation in commerce. Materials investigated by the Department are in promising cases submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

The work of this Department is chiefly initiated by the Home and Overseas Governments. Arrangements have also been made whereby British representatives in foreign countries may transmit to the Institute, for investigation, such raw materials of the countries to

which they are appointed as are likely to be of interest to British manufacturers and merchants.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Application for such investigations should be made, in writing, to the Director.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal raw materials which have been investigated and valued commercially during recent years, and as to which full information can be supplied. A reference collection of standard raw materials of commerce is also available for inspection.

The Department works in co-operation with the Agricultural, Mines and other Technical Departments and Institutions in the Dominions, Colonies and India, whose operations it supplements by undertaking investigations and enquiries of a special scientific or technical character connected with agricultural or mineral development, as well as enquiries relating to the composition and commercial valuation of products (animal, vegetable or mineral) which can be more efficiently conducted at home in consultation with manufacturers and merchants with a view to the local utilisation of these products or to their export.

Mineral Surveys have been conducted in countries of which the mineral resources were little known, all minerals found that were likely to be of commercial importance being forwarded to the Imperial Institute for examination and the determination of their composition and commercial value. Reports on the results of mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria and Nyasaland have been published (see p. viii). The work of the Imperial Institute on minerals is carried on with the advice of the Committee on Mineral Resources.

Technical Information Bureau: Intelligence.—This is a branch of the Scientific and Technical Research Department formed to deal with the large and increasing number of enquiries received by the Imperial Institute from

manufacturers, merchants and others, throughout the Empire. The Bureau devotes special attention to questions relating to the raw materials required for the industries of the Empire. It supplies technical information to enquirers, dealing with various problems in connection with the supply and disposal of raw materials of all kinds.

Public Exhibition Galleries.—The collections, illustrative of the present condition and industrial and commercial resources of the Dominions, Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute. The galleries are open free to the public, daily (except Sundays, Good Friday and Christmas Day), from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

The following Dominions, Colonies, Protectorates, etc., are represented by Collections, which are in charge of Technical Superintendents:

Canada, Newfoundland; Jamaica, Turks and Caicos Islands, British Honduras, British Guiana, Bahamas, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, Papua, Northern Territory; New Zealand and Samoa; Fiji, Western Pacific Islands; Union of South Africa, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Nigeria and Cameroons; Kenya Colony, Zanzibar and Pemba; Uganda; Somaliland; Egypt, Sudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements, the Federated Malay States; North Borneo; and the Indian Empire.

Arrangements are made to conduct schools and educational institutions through the Galleries and to explain the exhibits. Guide-lecturers give demonstrations in the Galleries at stated times.

At the Central Stand and Enquiry Office in the main gallery there are available, either for free distribution or for sale, handbooks, pamphlets, circulars, etc., relating

to the commerce, agriculture, mining, and other industries of the various countries of the Empire, and also to emigration. The publications of the Imperial Institute are also obtainable. Lists of all these publications are provided.

Ceylon Rubber Research Scheme.—In 1913 a scheme of research for the improvement of plantation rubber was established by the Ceylon Government and certain planting companies in the Colony in co-operation with the Imperial Institute, the general supervision being vested in Committees in Ceylon and in London. An independent scheme of rubber research was at that time conducted in the Colony by the Rubber Growers' Association. The existence of these two schemes involved some duplication of investigations, and in 1920 arrangements were made for their amalgamation. Under the new scheme, representatives of the Rubber Growers' Association were added to the Committee appointed by the Government of Ceylon to administer the scheme in the Colony, and also to the London Committee, which supervises the work carried out at the Imperial Institute. The London Committee includes a representative of the Research Association of British Rubber and Tyre Manufacturers, with whom co-operation has been arranged in dealing with questions relating to raw rubber which require investigation. A list of the members of this Committee is given on page xv.

The funds for carrying on the Scheme are provided by contributions from the Ceylon Government and the Rubber Growers' Association, and by subscriptions from planters and others connected with the rubber industry in the Colony who are not members of the Rubber Growers' Association.

Tropical African Services Course.—Courses of instruction in certain specified subjects are given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa.

Library.—The library of the Imperial Institute contains a large collection of works of reference, and is regularly supplied with the more important official publications and with many of the principal newspapers and periodicals of the United Kingdom, the Dominions, the Colonies, India and Foreign Countries. Special attention is given to publications relating to tropical agriculture and forestry, mineral resources, and the production and utilisation of raw materials.

The library is also provided with a large collection of maps of the Dominions, the Colonies and India.

Conference Rooms.—These rooms, on the principal floor, are used for meetings and receptions.

The Cowasjee Jehangier Hall.—The Bhownaggree corridor and rooms in connection with the Cowasjee Jehangier Hall belong to the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

Publications

Bulletin of the Imperial Institute.—The Bulletin is published quarterly by Mr. John Murray, 50A, Albemarle Street, London, and may be purchased through any bookseller. It contains records of the principal investigations carried out at the Imperial Institute, and special articles chiefly relating to the industrial utilisation of raw materials and progress in tropical agriculture and production.

Handbooks to the Commercial Resources of the Tropics.—Under the authority of the Secretary of State for the Colonies the Institute has issued a series of handbooks dealing with the Commercial Resources of the Tropics, with special reference to West Africa. The handbooks have been published by Mr. John Murray. The volumes issued, two of which are now in their second edition, are: *The Agricultural and Forest Products of British West Africa*, by Gerald C. Dudgeon, C.B.E., formerly Consulting Agriculturist and Director-General of Agriculture in Egypt, and

Inspector of Agriculture for British West Africa; *Cocoa: Its Cultivation and Preparation*, by W. H. Johnson, F.L.S., formerly Director of Agriculture in Southern Nigeria; *Rubber: Its Sources, Cultivation and Preparation*, by Harold Brown, Scientific and Technical Department, Imperial Institute; and *Cotton and other Vegetable Fibres: their Production and Utilisation*, by Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute.

Monographs on Mineral Resources.—A series of monographs on mineral resources with special reference to the British Empire is being issued with the assistance of the Mineral Resources Committee of the Imperial Institute. These monographs draw attention to the sources of supply of important minerals within the Empire as compared with those which occur in foreign countries, and give information respecting commercial uses and value of these minerals. The following monographs have been published: Zinc Ores, Manganese Ores, Tin Ores, Tungsten Ores, Molybdenum Ores, Chromium Ore, Nickel Ores, Cobalt Ores, Vanadium Ores, Platinum Metals, Copper Ores, Lead Ores, Mercury Ores, Silver Ores, Coal, Petroleum, Oil Shales, and Potash. Other monographs are in course of preparation, dealing with aluminium, antimony, bismuth and gold.

Map and Diagrams of Metal Resources.—A new and enlarged edition of this Map and Diagrams, prepared at the Imperial Institute with the advice of the Imperial Institute Committee on Mineral Resources, has been issued. The chief British countries of occurrence and production of the principal minerals are shown on the map. The diagrams give the outputs of these countries in relation to the production of other countries of the world. The metals dealt with are: gold, silver, platinum, copper, tin, lead, zinc, antimony, aluminium, bismuth, iron, manganese, chromium, nickel, tungsten, molybdenum, vanadium, and mercury.

The map and diagrams can be obtained unmounted or mounted on rollers as a wall map.

Mineral Survey Reports.—The following reports on the results of mineral surveys conducted in connection with the Scientific and Technical Department of the Imperial Institute have been published in the Miscellaneous Series of Colonial Reports: *Ceylon* (five reports), 1903–4, 1904–5, 1905–6, 1906–8, 1909–10; *Northern Nigeria* (five reports), 1904–5 (two), 1905–6, 1906–7, 1907–9; *Southern Nigeria* (nine reports), 1903–4 and 1904–5, 1905–6, 1906–7, 1907–8, 1908–9, 1910, 1911, 1912, 1913; *Nyasaland Protectorate* (three reports), 1906–7, 1907–8, 1908–9.

Reports of the Indian Trade Enquiry.—In 1916, the Secretary of State for India requested the Committee for India of the Institute to enquire into and report on the possibilities of extending the industrial and commercial utilisation of the principal Indian raw materials in this country and elsewhere in the Empire. Special Committees were appointed to deal with the more important groups of Indian materials, to consider the results of investigations and enquiries already conducted at the Imperial Institute, and to obtain the views of leading merchants, manufacturers, and other users of the raw materials of India. A number of reports of these Committees have been published, viz.: *Hides and Skins; Oil Seeds; Rice; Timbers and Paper Materials; Jute and Silk; Lac, Turpentine and Rosin;* and *Cinchona Bark and Myrobalans.* The reports contain important information and recommendations regarding the extension of the industrial and commercial utilisation of Indian raw materials, as well as statements on the general position of each commodity prepared at the Imperial Institute for the use of the Committees.

Selected Reports from the Scientific and Technical Department.—These reports, which are issued in the Miscellaneous Series of Colonial Reports, contain a summary of the results of

technical and commercial investigation of certain raw materials conducted in the Scientific and Technical Research Department of the Imperial Institute since 1903. Five of these Selected Reports have been published: Part I. "Fibres" (1909); Part II. "Gums and Resins" (1909); Part III. "Foodstuffs" (1910); Part IV. "Rubber and Gutta Percha" (1912); Part V. "Oilseeds, Oils, Fats and Waxes" (1914). A separate monograph on "Oil Seeds and Feeding Cakes" was published for general information during the war. It deals with the production and utilisation of copra, palm kernels, ground nuts, sesame seed, and mowra seed, and the oils and feeding cakes obtained from them. A collection of earlier reports was printed in a volume of "Technical Reports and Scientific Papers" issued by the Imperial Institute in 1903.

Organisations with Headquarters at the Institute

International Association for Tropical Agriculture, British Section.—The object of this Association, the Central Bureau of which is in Paris, is to promote the scientific and practical study of all questions connected with tropical agriculture, including the development and utilisation of natural resources, and to arrange for International Congresses. The British Section has its headquarters at the Imperial Institute. Members of the British Section receive the Bulletin of the Imperial Institute and are permitted to use the library and reading-rooms of the Imperial Institute.

Empire Forestry Association.—This Association, which is working in conjunction with the Imperial Institute Advisory Committee on Timbers, has been provided with office accommodation at the Imperial Institute.

Overseas Nursing Association.—An office has been allotted to this Association, the principal object of which is the selection of trained hospital and private nurses for service in the Crown Colonies and Dependencies.

African Society.—This Society has its office at the Imperial Institute.

Northbrook Society.—This Society has been allotted accommodation for a Library and Reading Room in the Indian Section of the Imperial Institute, entered by the East Public Entrance to the Exhibition Galleries and the Bhownaggree Corridor.

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[1] *Transferred temporarily from Senior Technical Superintendent, Public Exhibition Galleries.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

BRITISH HONDURAS TIMBERS

PART II

IN the last number of this BULLETIN (1923, **21**, 569) a report was published on the results of examination of four timbers sent to the Imperial Institute from British Honduras. Four further timbers from this Colony have now been tested and are dealt with in the present report. As in the case of those examined previously the mechanical properties and working qualities have been determined in the timber-testing laboratory and the results communicated to the Imperial Institute Advisory Committee on Timbers, who, after inspecting the materials, have given their opinion as to the purposes for which they could be utilised and their commercial possibilities in this country.

The four timbers now reported on are as follows: the information as to their local uses has been supplied by the Forestry Officer, British Honduras, and their botanical identity has been determined at Kew.

1. *Bullet Wood* (*Terminalia Buceras*, Benth. and Hook. f.). Rarely cut on account of its hardness. Is occasionally used for piles, and lasts well.

2. *Nargusta Wood.*—Used for verandah boarding and stands exposure well. Large supply available. It was not possible for the botanical source of this wood to be determined from the material provided.

3. *Pine Wood* (*Pinus caribaea*, Morelet).—Used for telegraph-poles and posts in house-building. Resinous. Excellent in wet ground. Very lasting.

4. *Tubroos Wood* (*Enterolobium cyclocarpum*, Griseb.).—Much used for small boats, in which it lasts well.

Bullet Wood (*Terminalia Buceras*)

The specimens of bullet wood received at the Imperial Institute consisted of five planks 9 ft. long, 6 to 15 in. wide and 1½ in. thick; two planks 9 ft. long, 9 in. wide and 4 in. thick; and one plank 7 ft. long, 18 in. wide and 4 in. thick.

The wood was light greenish-brown and generally in sound condition. The bark, which was intact and firmly attached to the wood, was about ¼ in. thick, light brown, and fairly hard but brittle. The grain was wavy, alternating spiral, and of open appearance due to the numerous pores. The fibres were of medium length.

In *transverse section* the wood was greenish-brown, with numerous densely distributed pores, arranged in undulating lines. The rays were seen as fine, light lines, and the rings, which were well defined and averaged from 7 to 10 to the inch, were bounded by a fine, light yellow line, sometimes followed by a narrow poreless zone.

In *radial section* the wood was light greenish-brown. The pores, which contained some resin, were seen as fairly large, brownish grooves, their appearance and arrangement being typical of wavy, alternating spiral grain. The rays appeared as narrow, lustrous yellow stripes, the rings being vaguely indicated by narrow bands.

In *tangential section* the colour of the wood and the appearance of the pores were as in the radial section. The rays were seen as short, narrow lines, tapering at the ends and slightly darker than the surrounding wood. The rings were occasionally represented by poreless zones.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table :

Summary of Results of the Mechanical Tests on Bullet Wood
(Terminalia Buceras)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test* (*central loading*) :				
Maximum calculated longitudinal shear	*lb./sq. in.*	537	242	355
Modulus of rupture	,,	15,050	8,430	10,918
Fibre stress at elastic limit	,,	9,690	6,870	7,978
Modulus of elasticity	,,	1,670,000	1,110,000	1,467,000
Elastic resilience	*inch-lb./cu. in.*	2·91	1·67	2·12
B.—*Compression test along the grain* (24 *in. length specimen*) :				
Crushing strength	*lb./sq. in.*	5,870	4,500	5,033
Fibre stress at elastic limit	,,	4,330	2,735	3,179
Modulus of elasticity	,,	1,950,000	991,000	1,395,000
Elastic resilience	*inch-lb./cu. in.*	4·65	2·38	3·15
C.—*Compression test along the grain* (8 *in. length specimen*) :				
Crushing strength	*lb./sq. in.*	7,870	5,090	6,357
Fibre stress at elastic limit	,,	6,120	3,500	4,755
Modulus of elasticity	,,	1,372,000	857,000	1,137,000
Elastic resilience	*inch-lb./cu. in.*	11·50	5·57	7·82
D.—*Compression test across the grain* :				
Load at elastic limit	*lb.*	12,000	10,000	11,150
Fibre stress at elastic limit	*lb./sq. in.*	3,060	2,560	2,815
E.—*Shearing tests along the grain* :				
Radial—				
Maximum load supported	*lb.*	9,560	7,610	8,414
Shearing strength	*lb./sq. in.*	2,350	1,850	2,049
Tangential—				
Maximum load supported	*lb.*	8,790	7,410	8,046
Shearing strength	*lb./sq. in.*	2,160	1,810	1,981
Specific gravity		1·020	0·866	0·966
Weight per cubic foot	*lb.*	63·7	54·0	60·3
Moisture	*per cent.*	16·2	10·9	13·8

Results of Working Tests

(1) *Sawing.*—The wood can be cut easily with hand and power saws.

(2) *Planing.*—It is difficult to obtain a smooth surface, owing to the wavy, alternating spiral grain, as the wood "picks up" badly.

(3) *Boring.*—Centre bits, bradawls and gimlets give clean holes but are hard to use. Twist drills and auger bits cut fairly readily, but heat up.

(4) *Nailing and Screwing.*—Screws require good-sized

holes before they can be driven in, but they hold well. Nails tend to bend, as the wood is tough, and sometimes cause splitting.

(5) *Mortising and Dovetailing.*—The wood cuts moderately easily in the mortising machine, and fairly strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—This is not difficult, but the wood tends to tear and pick up.

(7) *Turning.*—The wood is fairly easy to turn, but the fibres tear and only a rough finish is obtainable with tools. A good surface can be obtained with sand-paper.

(8) *Glueing.*—The wood absorbs the glue and gives good joints.

(9) *Polishing and Varnishing.*—Satisfactory results are obtained.

(10) *Staining.*—The wood gives good results.

Remarks

Bullet wood is a fairly heavy and hard timber, of good but nondescript appearance. It can be worked with moderate ease with most power tools, but with hand tools it is difficult to obtain good results owing to the toughness of the wood and the nature of its grain.

In the mechanical tests the wood was found to be fairly flexible, and to have moderate strength in transverse bending and compression along the grain; it gave a moderately high resistance to compression across the grain and had a good shearing strength. It should be a strong, durable wood for outdoor work, such as for posts, piles, etc., and for general purposes.

The Committee on Timbers stated that it showed no special figure or character and would therefore be unsuitable for decorative purposes in cabinet-making. The difficulties observed in the working tests referred to above would interfere with the use of the wood for general building purposes. It might be useful where a plain strong wood is required, but otherwise its prospect of finding a market in the United Kingdom is doubtful.

Nargusta Wood

The specimens of nargusta wood received at the Imperial Institute consisted of eight planks 9½ ft. long, 6 to 12 in. wide, and 1½ in. thick ; two planks 9½ ft. long, 8 in. wide, and 4 in. thick ; and a plank cut through the centre of the tree, 6½ ft. long, 20 in. wide, and 4 in. thick.

The wood was light yellow with extensive reddish-brown bands, the sapwood being light yellow with occasional brownish-green discolorations, and about 3 in. wide. The wood was in sound condition. The bark, which was light brown and about ¼ in. thick, was intact, but could be readily removed. The wood had a wavy, alternating spiral grain (in some cases straight, alternating spiral) ; it was smooth and compact, but showed prominent resin ducts. The fibres were of medium length.

In *transverse section* the wood was light greenish-yellow, with reddish bands. The resin ducts or pores were very numerous and evenly distributed. The rays appeared as numerous fine, light, equidistant lines. The rings were inconspicuous, about 6 to 8 to the inch, with darker-coloured, narrow, poreless zones as boundaries.

In *radial section* the wood was slightly lighter in colour than in transverse section. The pores were seen as conspicuous brown grooves with the distribution and appearance typical of alternating spiral grain. The rays appeared as narrow, whitish lines ; the rings were ill-defined, but were indicated by the boundaries, which were visible as narrow, slightly darker lines.

In *tangential section* the colour of the wood was similar to that of the radial section. The pores appeared as numerous, prominent, brown grooves. The rays were seen as short, fine, light lines ; the rings were invisible.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table :

Summary of Results of the Mechanical Tests on Nargusta Wood

	Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)* :			
Maximum calculated longitudinal shear . . *lb./sq. in.*	326	154	260
Modulus of rupture . "	9,250	4,310	7,322
Fibre stress at elastic limit "	7,720	3,120	5,567
Modulus of elasticity . "	1,490,000	625,000	1,039,000
Elastic resilience *inch-lb./cu. in.*	2·08	0·65	1·52
B.—*Compression test along the grain* (24 *in. length specimen*) :			
Crushing strength . *lb./sq. in.*	5,780	3,320	4,625
Fibre stress at elastic limit "	4,750	1,935	3,458
Modulus of elasticity . "	1,830,000	568,000	1,197,000
Elastic resilience *inch-lb./cu. in.*	5·18	2·78	4·19
C.—*Compression test along the grain* (8 *in. length specimen*) :			
Crushing strength . *lb./sq. in.*	6,640	4,080	5,305
Fibre stress at elastic limit "	6,050	2,630	4,220
Modulus of elasticity . "	1,513,000	517,000	1,026,000
Elastic resilience *inch-lb./cu. in.*	9·43	4·45	6·92
D.—*Compression test across the grain* :			
Load at elastic limit . *lb.*	8,900	6,800	8,055
Fibre stress at elastic limit *lb./sq. in.*	2,320	1,760	2,068
E.—*Shearing tests along the grain* :			
Radial—			
Maximum load supported *lb.*	6,840	5,830	6,543
Shearing strength . *lb./sq. in.*	1,710	1,460	1,624
Tangential—			
Maximum load supported *lb.*	7,730	5,780	6,530
Shearing strength . *lb./sq. in.*	1,900	1,450	1,618
Specific gravity	0·896	0·759	0·833
Weight per cubic foot . *lb.*	55·9	47·4	52·1
Moisture . . . . . *per cent.*	20·20	13·60	17·08

Results of Working Tests

(1) *Sawing.*—The wood cuts readily with hand and power saws.

(2) *Planing.*—It is difficult to obtain a good surface as the wood "picks up" and tears. Fairly good results can be obtained with a fine-cutting smoothing plane.

(3) *Boring.*—The wood cuts moderately well with twist drill and centre-bit but there is a tendency to heat up. Gimlets and bradawls are hard to use as the wood is fairly tough.

(4) *Nailing and Screwing.*—Nails can be driven in easily

and they hold well; holes are necessary for screws. There is a tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts readily in the mortising machine, but tends to tear and split. Moderately strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood cuts easily, but its grain causes "picking up."

(7) *Turning.*—The wood cuts well in the lathe, but a good surface is difficult to obtain owing to the tearing out of the fibre bundles.

(8) *Glueing.*—Fair strength is obtainable in glue joints.

(9) *Polishing.*—Satisfactory.

(10) *Varnishing and Staining.*—Satisfactory.

Remarks

Nargusta is a moderately hard and medium heavy wood of good appearance. It can be worked fairly readily with power tools; with hand tools it is more difficult to obtain good results owing to the toughness of the wood and the alternating spiral grain. It has only moderate bending, crushing, and shearing strengths, and a relatively low modulus of elasticity, but shows a good resistance to compression across the grain.

The wood cuts well as a veneer, giving an excellent decorative figure, but according to manufacturers who tested it from this standpoint, it has too much sapwood, only a comparatively narrow portion of the wood having the reddish-brown markings which give the ornamental appearance. Its chief uses should be in furniture manufacture, and for outdoor work and general purposes.

The Committee regarded this product as a good timber of considerable ornamental value and considered that if the figure is general in the wood it would find a market for veneer. The veneers inspected by the Committee were regarded as technically good and of attractive figure, though the red colour might be an objection. It was suggested that enquiry should be made as to (1) whether nargusta wood is regularly figured,

and (2) the average size of the heart-wood, and information on these points has therefore been requested from the Colony.

Pine Wood (*Pinus caribæa*)

The specimens of pine wood received at the Imperial Institute consisted of five planks 10 ft. long, 6 to 10 in. wide, and 1½ in. thick; two planks 10 ft. long, 8 and 9 in. wide, and 4 in. thick; and a plank cut through the centre of the tree, 6½ ft. long, 16 in. wide and 4 in. thick.

The wood was light yellow with reddish-brown, lustrous bands, and showed irregular greenish-grey discolorations which extended from 3 to 5 in. from the outside surface of the tree. The wood, which was generally in sound condition, had the characteristic odour of pine timber, and was very resinous. The grain was straight and even, of medium texture and fairly short-fibred.

In *transverse section* the wood was light yellowish-brown, with resinous bands of a brown tint. The resin ducts were few and scattered, but were completely filled. The rays appeared as numerous, thin, yellowish lines; the rings, 3 to 5 to the inch, were indicated by a narrow, resinous, brown boundary line, each complete ring containing a number of subsidiary narrow rings.

In *radial section* the wood was light yellow with reddish-brown bands, with occasional resin ducts seen as fair-sized, red-brown grooves. The rays were visible as long, narrow, lustrous yellow stripes; the rings were indicated by lighter and darker shades of yellow-brown, with long, narrow, brown lines as boundaries.

In *tangential section* the colour of the wood was similar to that of the radial section. The rays were seen as numerous, short, fine lines, slightly darker in colour than the surrounding wood; the rings were indicated by variation in colour.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table:

Summary of Results of the Mechanical Tests on Pine Wood
(Pinus caribæa)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test* (*central loading*):				
Maximum calculated longitudinal shear	*lb./sq. in.*	527	381	452
Modulus of rupture	,,	14,900	10,780	12,743
Fibre stress at elastic limit	,,	10,880	7,660	8,890
Modulus of elasticity	,,	1,732,000	1,357,000	1,583,000
Elastic resilience	*inch-lb./cu. in.*	3·62	1·91	2·63
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	6,520	4,580	5,790
Fibre stress at elastic limit	,,	5,150	3,060	4,182
Modulus of elasticity	,,	1,710,000	1,281,000	1,549,000
Elastic resilience	*inch-lb./cu. in.*	6·55	3·08	4·73
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	7,560	6,430	7,132
Fibre stress at elastic limit	,,	5,960	4,960	5,604
Modulus of elasticity	,,	1,597,000	1,220,000	1,389,000
Elastic resilience	*inch-lb./cu. in.*	11·33	7·38	8·92
D.—*Compression test across the grain*:				
Load at elastic limit	*lb.*	6,400	5,250	5,750
Fibre stress at elastic limit	*lb./sq. in.*	1,670	1,340	1,474
E.—*Shearing tests along the grain*:				
Radial—				
Maximum load supported	*lb.*	7,100	5,530	6,066
Shearing strength	*lb./sq. in.*	1,735	1,360	1,505
Tangential—				
Maximum load supported	*lb.*	8,110	6,330	7,365
Shearing strength	*lb./sq. in.*	1,985	1,545	1,808
Specific gravity		0·869	0·582	0·745
Weight per cubic foot	*lb.*	54·2	36·3	46·4
Moisture	*per cent.*	16·10	9·78	13·04

Results of Working Tests

(1) *Sawing.*—The wood can be cut easily with power or hand saws, but the resinous nature of the saw-dust causes it to stick to the teeth.

(2) *Planing.*—The wood can be planed with facility, but the base of the plane becomes sticky.

(3) *Boring.*—Twist drills, bradawls, gimlets, and centre-bits give clean holes, but there is a slight tendency to bind.

(4) *Nailing and Screwing.*—Nails and screws can be

driven in easily, and hold well. The wood has no tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts easily in the machine, and fairly strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood cuts cleanly, and does not split or tear.

(7) *Turning.*—Good results are possible, a smooth finish being obtainable with tools.

(8) *Glueing.*—Strong joints are obtainable.

(9) *Polishing and Varnishing.*—Satisfactory.

(10) *Staining.*—The wood takes stain moderately well.

Remarks

This pine wood is of moderate hardness and weight; it is of fairly good appearance, works well with all hand and power tools, and is firm, uniform, resinous, and straight-grained. Its strength values compare favourably with those of longleaf pine (*Pinus palustris*), which is the strongest and stiffest of pines; the bending, crushing, and shearing strengths are all satisfactory. The modulus of elasticity is, however, considerably lower than that given for longleaf pine and Cuban pine by the United States Forestry Division, the average value of the modulus of elasticity for the present specimens being 1,507,000 lb. per sq. in., whereas that quoted for longleaf pine (*Pinus palustris*) is 2,070,000 to 2,110,000 lb. per sq. in., and that for Cuban pine (*Pinus caribæa*, Morelet, *Pinus heterophylla*, Sudworth) 2,370,000 lb. per sq. in.

Snow, in *Wood and other Organic Structural Materials*, describes *P. caribæa* as resembling and being marketed with longleaf pine, which is used in heavy constructional work, and for ship-building, cars, docks, beams, ties, flooring, house-trim, etc.

The Committee regarded the product as a useful and promising timber which might take the place of pitch pine for many purposes if available in sufficient quantities at a suitable price. They suggested that information should also be obtained as to (1) the average sizes and lengths in which the wood could be supplied, and (2) whether the standing trees have been tapped for turpentine, and

stated that if the replies were satisfactory it might be worth while to arrange for a trial shipment of the wood to be forwarded to this country.

TUBROOS WOOD (*ENTEROLOBIUM CYCLOCARPUM*)

The specimens of tubroos wood received at the Imperial Institute consisted of eight planks 9½ ft. long, 6 to 16 in. wide and 1¼ in. thick; two planks 9½ ft. long, 9 in. wide and 4 in. thick; and one plank cut through the centre of the tree, 6 ft. long, 18 in. wide and 4 in. thick.

The colour of the wood was reddish-brown; the sapwood, which was about 1¼ in. wide, was light yellow with occasional greyish discolorations at the outside. The wood was generally in sound condition. No bark was present.

The grain was straight, with a tendency to alternating spiral. The wood on one side of the tree was moderately long-fibred, whilst on the other it was apparently short-fibred and appeared to be "dead"; a number of compression failures occurred in the wood from the latter side of the tree.

In *transverse section* the wood was dark reddish-brown, with numerous large ducts which were partially filled with a resinous substance. The rays were seen as very numerous, uniform, fine, light lines. The rings, which averaged 4 to 6 to the inch, were shown by a dark greyish boundary line.

In *radial section* the wood was golden-brown and slightly lustrous; the resin ducts were seen as numerous large and conspicuous grooves with soft, light-coloured substance at the sides, the centres usually showing dark resinous contents. The appearance of these grooves indicated an alternating spiral grain. The rays appeared as very numerous light flecks, whilst the rings were feebly indicated by dark greyish, narrow bands.

In *tangential section* the wood was similar in colour and the resin ducts had the same appearance as in the radial section. The rays were visible as minute, fine, light lines. The rings were occasionally indicated by the boundary lines.

Results of Mechanical Tests

The results of the mechanical tests are summarised in the following table :

Summary of Results of the Mechanical Tests on Tubroos Wood (Enterolobium cyclocarpum)

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test* (*central loading*) :				
Maximum calculated longitudinal shear	*lb./sq. in.*	303	168	255
Modulus of rupture	,,	8,570	4,750	7,180
Fibre stress at elastic limit	,,	7,050	4,480	5,830
Modulus of elasticity	,,	1,610,000	738,000	1,142,000
Elastic resilience	*inch-lb./cu. in.*	2·41	1·12	1·63
B.—*Compression test along the grain* (*24-in. length specimen*) :				
Crushing strength	*lb./sq. in.*	4,370	3,640	3,983
Fibre stress at elastic limit	,,	3,920	2,770	3,123
Modulus of elasticity	,,	1,500,000	963,000	1,247,000
Elastic resilience	*inch-lb./cu. in.*	6·45	2·47	3·53
C.—*Compression test along the grain* (*8-in. length specimen*) :				
Crushing strength	*lb./sq. in.*	4,660	4,020	4,372
Fibre stress at elastic limit	,,	4,220	3,280	3,603
Modulus of elasticity	,,	1,800,000	832,000	1,263,000
Elastic resilience	*inch-lb./cu. in.*	6·77	2·43	4·42
D.—*Compression test across the grain* :				
Load at elastic limit	*lb.*	4,100	3,050	3,558
Fibre stress at elastic limit	*lb./sq. in.*	1,032	755	896
E.—*Shearing tests along the grain* :				
Radial—				
Maximum load supported	*lb.*	4,550	3,430	4,059
Shearing strength	*lb./sq. in.*	1,145	867	1,031
Tangential—				
Maximum load supported	*lb.*	5,420	4,040	4,594
Shearing strength	*lb./sq. in.*	1,380	1,002	1,155
Specific gravity		0·672	0·434	0·513
Weight per cubic foot	*lb.*	41·9	27·1	32·1
Moisture	*per cent.*	24·5	12·3	16·0

Results of Working Tests

(1) *Sawing.*—The wood cuts easily with hand and power saws.

(2) *Planing.*—The wood planes easily and smoothly with jack and smoothing planes, except in radial wood where it " picks up " badly.

(3) *Boring.*—The wood cuts readily with centre bit, morse drill, bradawl, and gimlet, but there is a tendency to tear. Auger-bits give cleaner holes.

(4) *Nailing and Screwing.*—Nails and screws can be driven in with ease, and hold well. There is a very slight tendency to split.

(5) *Mortising and Dovetailing.*—The wood cuts easily in mortising machines, being fairly soft, but only moderately strong joints are obtainable.

(6) *Working with Gouge and Chisel.*—The wood cuts with facility, but " drags up."

(7) *Turning.*—The wood turns easily in the lathe, but the fibre bundles tear unless care is taken and sharp tools are used. A good finish can be obtained with sand-paper.

(8) *Glueing.*—Good strength is obtainable in glue joints, the wood usually giving way before the glue.

(9) *Polishing.*—The wood requires careful " filling," owing to the large resin ducts, but has a good appearance when finished.

(10) *Varnishing.*—Fairly good results are obtainable.

(11) *Staining.*—The wood absorbs stain readily, and satisfactory results can be obtained.

Remarks

Tubroos wood is moderately soft and light, and has a good appearance, similar in some respects to that of coarse cedar. It is straight-grained and free from knots ; it works well with most hand and power tools, and a good finish is usually obtainable.

In the mechanical tests, low strength values were obtained in transverse bending, compression along and across the grain, and shearing. The " dead " wood on one side of the tree did not cause large differences of strength, but it reduced the average values of the modulus of elasticity. This fault should not be general in tubroos, and the wood should find a market for general workshop purposes, cheap furniture and other light work where great strength is not required.

The Committee stated that this timber would fall into the class of numerous woods which can be used as substi-

tutes for mahogany, for which purpose it might be used for certain work in coach building. It was considered that it might find a market comparable to that of Philippine "luan" and possibly realise 3*d*. per foot in the log. The Committee were of opinion that if the timber can be supplied in good sizes and at satisfactory prices it would be worth while to ship a trial consignment in order to test the market. It was pointed out to the British Honduras authorities, however, that it should be ascertained whether the presence of dead wood as in the specimens examined is of general occurrence, as many other cheap mahogany substitutes already on the market are without such faults.

BRITISH GUIANA WOODS FOR PAPER-MAKING

The thirteen specimens of timbers and palm stems which are the subject of this report were forwarded to the Imperial Institute by the Commissioner of Lands and Mines, Georgetown, with the request that they should be examined with the object of ascertaining their value for the manufacture of paper pulp.

Botanical specimens of the trees were also forwarded in order to determine their identity, and these were submitted to the Royal Botanic Gardens, Kew.

On the next page is a list of the specimens, giving the local names supplied by the Commissioner, the botanical names as determined by the authorities at Kew, and remarks regarding the specimens furnished in a statement by the Forestry Officer, British Guiana. The material was collected from land of varying kinds along the Kamuni River, a tributary of the Demerara River.

In all cases the material was examined chemically, the percentages of moisture, ash and cellulose being determined. Paper-making trials were carried out in the laboratory by treating the wood with caustic soda under conditions similar to those employed for the production of paper-pulp on a commercial scale. Except in certain specified cases, the wood was freed from bark before being cut into chips for the purpose of the trial.

1	Bara-bara.	*Diospyros guianensis*, Gürke (*D. Paralea*, Steud.) (Ebenaceae).	Collected from swampy, clay land; grows also on sandy hills; scattered. Wood a bright yellow when freshly cut, turns on exposure to a light brown. A soft sapwood tree of medium size.
2	Baramalli.	*Tabebuia* sp.? (Bignoniaceæ). As the specimen bears neither flowers nor fruits, the identification is uncertain.	Collected from sandy hill slope; plentiful. Wood a light brown. A soft sapwood tree, growing to a large size; two or more varieties.
3	Fotui.	*Jacaranda Copaia*, D. Don. (Bignoniaceæ).	Collected from sandy bank of creek; fairly plentiful, but scattered; wood a greyish-white colour. A soft sapwood tree of medium size; a rapid grower.
4	Haiari-balli.	Leguminosæ. Possibly a species of *Diplotropis*. Without flowers or fruit, it is impossible to determine the genus with certainty.	Collected from swampy, sandy bank of creek; fairly plentiful in places. Heartwood a light brown, not sharply defined from the wide, lighter brown or white sapwood. Trees grow to fairly large size.
5	Hubu (or Hog Plum).	*Spondias lutea*, Linn. (Anacardiaceæ).	Collected from low sand hill; grows also on clay and sandy clay; scattered. A white, soft, sapwood tree of medium to large size; a rapid grower.
6	Hurowassa.	*Pithecolobium trapezifolium*, Benth. (Leguminosæ).	Collected from sandy slope; fairly plentiful. Heartwood a light brown, not sharply defined from the narrow white sapwood. A medium to large sized tree.
7	Karahora.	*Schefflera depressa*, Sprague, n. sp. (Araliaceæ). The American species of Schefflera were formerly referred to the genus Sciadophyllum, which is now treated as a synonym of Schefflera by most botanists.	Collected from sandy bank of creek; grows also on sandy-clay and clay flats and hills; fairly plentiful but scattered. A light, white sapwood tree with pith centre; a medium sized tree.
8	Kurukoruru.	*Diplotropis* sp.? (Leguminosæ). Until flowers are known the genus will remain uncertain. Specimens with similar fruits have, however, been referred to *Diplotropis*.	Collected from swampy, sandy creek bank; grows also on swampy slopes and flats; fairly plentiful in places. Heartwood a light brown, not sharply defined from the broad, white sapwood. Of medium to large size. Another variety has, apparently, no heartwood.
9	Long John.	*Triplaris surinamensis*, Cham. (Polygonaceæ).	Collected from flat clay land; plentiful in certain districts, scattered in others. A light brown, soft sapwood tree; of medium to large size; a rapid grower.
10	Wanasoro (or Congo Pump).	*Cecropia Juranyiana*, Aladár Richter. (Moraceæ).	Collected from sandy hill slope; found everywhere, plentiful in second growth and scattered in original forest. A white, very soft and light wood, with hollow jointed stem in upper portion. A small to medium sized tree; a rapid grower.
11	Manicole.	*Euterpe edulis*, Mart. (Palmæ).	Collected from swampy clay land; plentiful in swamp areas all over the colony. Stems up to 7 or 8 in diameter and up to 70 ft., or more, in height.
12	Ite (Aeta).	*Mauritia flexuosa*, Linn. (Palmæ).	Collected from swampy clay land; plentiful in certain swampy areas in most districts. Diameter of stems breast high, 14–15 in., enlarging considerably some distance up; up to 80 ft. or more in height.
13	Mukka-mukka.	*Montrichardia arborescens*, Schott. (Araceæ).	Grows abundantly in swamps and fringing the river banks all over the colony. Stems 5 or 6 in. in diameter and 8–20 ft. high.

No. 1. Bara-bara

This sample consisted of a log, 7 to 8 in. in diameter, of moderately soft, light-coloured wood, with rather rough bark $\frac{1}{16}$ in. thick.

The results of the chemical examination were as follows:

	Per cent.
Moisture	13·6
Ash	0·6
Cellulose in material as received	50·3
Cellulose expressed on the moisture-free wood	58·2

The ultimate fibres measured from 0·5 to 1·4 mm. in length, with an average of 0·9 mm.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
		Hours.			*Per cent.*
20	4	9	160° C	14·1	47

This treatment gave a good yield of well reduced pulp, which furnished a brown paper of good strength. The pulp bleached satisfactorily, and furnished a white paper of good strength and quality.

No. 2. Baramalli

This consisted of a log, 8 in. in diameter, of fairly hard wood, with rather rough bark nearly $\frac{1}{8}$ in. thick. The heartwood was light reddish-brown and the sapwood white to grey.

The following results were obtained on chemical examination:

	Per cent.
Moisture	13·0
Ash	1·2
Cellulose in material as received	50·6
Cellulose expressed on the moisture-free wood	58·2

The ultimate fibres measured from 0·8 to 2·6 mm. in length, with an average of 1·9 mm.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
		Hours.			*Per cent.*
20	4	9	160° C.	13·0	42

Under these conditions the material was fairly satisfactorily broken up, but a small quantity of hard particles remained in the pulp. The unbleached pulp yielded a paper of fair strength, which however showed dark specks. The pulp bleached readily and then yielded a soft paper of a good white colour, of fair strength and free from specks.

No. 3. Fotui

This consisted of a log of soft, greyish-white wood, 10 to 12 in. in diameter, with rough bark about $\frac{1}{4}$ in. thick.

Chemical examination gave the following results:

	Per cent.
Moisture	23·4
Ash	0 6
Cellulose expressed on material as received	45·1
Cellulose expressed on the moisture-free wood	58·9

The ultimate fibres measured from 0·6 to 1·3 mm. in length, with an average of 0·95 mm.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution	Time.	Temp.		
		Hours.			*Per cent.*
20	4	6	160° C.	9·9	46

The above treatment gave a good yield of well reduced pulp, which yielded a strong, pale brown paper. On bleaching it furnished a white paper of good quality.

No. 4. Haiari-balli

This consisted of a log, 10 to 11 in. in diameter, of fairly soft, white to greyish wood, with a fairly smooth bark $\frac{1}{10}$ in. thick.

The following results were obtained on chemical examination:

	Per cent.
Moisture	20·2
Ash	0·4
Cellulose in material as received	40·4
Cellulose expressed on the moisture-free wood	50·6

The ultimate fibres measured from 0·8 to 2·0 mm. in length, with an average of 1·3 mm.

Results of Paper-making Trials

Trial	Caustic soda used		Conditions of boiling		Parts of caustic soda consumed per 100 parts of wood	Yield of dry unbleached pulp expressed on wood as received.
	Parts per 100 parts of wood	Parts per 100 parts of solution	Time	Temp		
			Hours			Per cent.
A	20	4	6	160° C.	10·4	41
B	20	4	9	160° C.	12·8	36

The pulp obtained in Trial A was completely broken up and furnished a moderately strong, rather speckled, greyish-brown paper. The pulp bleached fairly readily and then furnished a white paper practically free from specks and of moderately good strength and quality.

A further trial (B) was made in order to ascertain whether the thin bark of this sample might be included with the wood for pulping. The pulp produced was similar to that of A and furnished a greyish-brown paper of good strength. The specks in this case were, however, more numerous and did not disappear on bleaching. The pulp bleached to a brownish-cream tint, but the paper made from it darkened somewhat on keeping.

No. 5. Hubu or Hog-plum

This sample consisted of a log, about 8 in. in diameter, of fairly soft, white wood with a rough bark $\frac{8}{10}$ in. thick.

The results of the chemical examination were as follows:

	Per cent.
Moisture	14·6
Ash	1·0
Cellulose in material as received	45·9
Cellulose expressed on the moisture-free wood	53·7

The ultimate fibres measured from 0·7 to 1·6 mm. in length, with an average of 1·1 mm.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
		Hours.			*Per cent.*
20	4	9	160° C.	14·9	40

The pulp produced under the above conditions was well reduced and gave a strong brown paper containing a few specks. It required fairly drastic treatment in bleaching, but the bleached pulp gave a strong white paper of good quality.

No. 6. Hurowassa

This consisted of a log, 10 in. in diameter, of fairly hard, compact wood, with a rough bark ¼ in. thick. The heartwood was light brown and the sapwood white.

Chemical examination gave the following results :

	Per cent.
Moisture	35·4
Ash	0·9
Cellulose in material as received	31·8
Cellulose expressed on the moisture-free wood	49·2

The ultimate fibres measured from 0·5 to 1·4 mm. in length, with an average of 0·9 mm.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp.		
		Hours.			*Per cent.*
20	4	6	160° C.	9·2	31

By the above treatment the wood was almost entirely disintegrated, and the pulp furnished a pale brown paper of fair strength. The pulp bleached readily and yielded a fairly strong, white paper.

No. 7. Karahora

This sample consisted of a log, 8 to 9 in. in diameter, of fairly soft, white wood, with pith $\frac{3}{8}$ in. in diameter and rather rough bark $\frac{1}{4}$ in. thick.

The results of the chemical examination were as follows:

	Per cent.
Moisture	15·0
Ash	0·6
Cellulose in material as received	47·6
Cellulose expressed on the moisture-free wood	56·0

The ultimate fibres measured from 0·4 to 1·8 mm. in length, with an average of 1 mm.

Results of Paper-making Trial

Caustic soda used		Conditions of boiling		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution	Time	Temp		
		Hours			*Per cent.*
20	4	6	160° C.	11·6	49

The conditions of treatment were sufficient to break up the wood completely and the pulp produced gave a strong, pale brown paper. The pulp bleached fairly readily, and then yielded white paper of good strength and quality.

No. 8. Kurukoruru

This consisted of a log, 10 to 12 in. in diameter, of hard, dense wood, with a thin, fairly smooth bark. The sapwood was white and the heartwood reddish.

The following results were obtained on chemical examination:

	Per cent.
Moisture	17·2
Ash	0·4
Cellulose in material as received	50·4
Cellulose expressed on the moisture-free wood	59·4

The ultimate fibres measured from 0·9 to 2·0 mm. in length, with an average of 1·3 mm.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time	Temp		
		Hours.			*Per cent.*
20	4	9	160° C.	11·2	41

This treatment gave a well disintegrated pulp which furnished a soft, pale brown paper of fairly good strength, and, after bleaching, a white paper of similar strength.

No. 9. Long John

This sample consisted of a log, about 8 in. in diameter, of fairly hard, light brown wood, with a rough bark $\frac{1}{8}$ in. thick.

The results of the chemical examination were as follows:

	Per cent.
Moisture	16·1
Ash	1 2
Cellulose in material as received	46·7
Cellulose expressed on the moisture-free wood .	55·7

The ultimate fibres measured from 0·5 to 1·7 mm. in length, with an average of 0·9 mm.

Results of Paper-making Trial

Caustic soda used		Conditions of boiling		Parts of caustic soda consumed per 100 parts of wood	Yield of dry unbleached pulp expressed on wood as received.
Parts per 100 parts of wood	Parts per 100 parts of solution	Time	Temp		
		Hours			*Per cent*
20	4	9	160° C	13·2	38

Treatment under the above conditions proved just sufficient to disintegrate the wood satisfactorily, with production of a light pinkish-brown pulp, which furnished paper of fair strength. It bleached fairly readily and then gave a white paper of similar strength.

No. 10. Wanasoro

This consisted of several logs, varying from 2 in. to 8 in. in diameter, of very soft, light wood, with rather

rough, fibrous bark. Each had a central cavity interrupted by hard septa at intervals of a few inches.

Chemical examination gave the following results:

	Per cent.
Moisture	11·8
Ash	2·1
Cellulose in material as received	54·1
Cellulose expressed on the moisture-free wood	61·3

The ultimate fibres measured from 0·6 to 1·6 mm. in length, with an average of 1·1 mm.

The bark was not removed from this wood for the paper-making trials.

Results of Paper-making Trials

Trial.	Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of wood.	Yield of dry unbleached pulp expressed on wood as received.
	Parts per 100 parts of wood.	Parts per 100 parts of solution.	Time.	Temp		
			Hours.			*Per cent.*
A	20	3	9	160° C.	13·3	48
B	24	4	9	160° C.	14·5	47

Treatment under the conditions of Trial A was insufficient for the satisfactory disintegration of the material, and the pulp obtained was full of specks and difficult to bleach. The unbleached pulp yielded a strong brown paper of fair quality, but the bleached pulp yielded paper which, though fairly strong, was of a pale brown tint and full of coarse, dark particles.

By the more drastic conditions of Trial B the wood was successfully broken up, the unbleached pulp furnishing a brown paper of good strength. The pulp bleached readily, and then yielded a strong paper of good white colour and free from specks.

In these trials both the bark and the hard septa were included, since it would be impracticable to remove them on a manufacturing scale. Trial B shows, however, that good pulp can be thus produced from the material in satisfactory yield, but the high consumption of soda and the drastic conditions of treatment are adverse features.

No. 11. Manicole

This sample consisted of sections of palm stem up to 10 ft. long and about 3 in. in diameter. Some sheathing leaves were also present. The material was very fibrous, but contained a large proportion of non-fibrous pithy matter.

The results of the chemical examination were as follows:

	Per cent.
Moisture	12·0
Ash	1·4
Cellulose in material as received	45·5
Cellulose expressed on the moisture-free material	51·7

The ultimate fibres measured from 0·4 to 2·6 mm. in length, with an average of 1·2 mm.

The paper-making trials in this case were conducted on the entire material.

Results of Paper-making Trials

Trial	Caustic soda used		Conditions of boiling		Parts of caustic soda consumed per 100 parts of stems	Yield of dry unbleached pulp expressed on stems as received
	Parts per 100 parts of stems	Parts per 100 parts of solution	Time	Temp		
			Hours			*Per cent*
A	20	4	6	160° C	13·4	45
B	24	4	9	160° C	15·1	40

The conditions of trial A were insufficient to break up the material satisfactorily. The dark brown, unbleached paper contained much incompletely disintegrated matter, and this became more apparent on bleaching, when a brownish, speckly paper was produced. The bleached and unbleached papers were both fairly strong.

The more drastic conditions of trial B gave a well reduced pulp, furnishing strong paper which shrank somewhat on drying and was rather "rattly." The pulp bleached readily and gave a rather harsh paper of good strength, white and free from specks.

No. 12. Ite (Aeta)

This sample consisted of a length of palm stem about 9 in. in diameter, split in four, with smooth bark about

⅛ in. thick. The material consisted of long fibrous strands embedded in soft pithy matter.

The stems were chemically examined with the following results:

	Per cent.
Moisture	13·6
Ash	0·6
Cellulose in material as received	43·5
Cellulose expressed on the moisture-free stems .	50·3

The ultimate fibres measured 0·8 to 3·3 mm. in length, with an average of 1·6 mm.

The entire material, including bark, was used for the paper-making trial.

Results of Paper-making Trial

Caustic soda used.		Conditions of boiling.		Parts of caustic soda consumed per 100 parts of stems.	Yield of dry unbleached pulp expressed on stems as received.
Parts per 100 parts of stems.	Parts per 100 parts of solution.	Time.	Temp.		
		Hours.			*Per cent.*
20	4	9	160° C.	12·6	28

The pulp produced by the above treatment was fairly well disintegrated, and gave a soft but coarse-fibred, brown paper of poor strength. It bleached fairly readily, and then furnished a soft, cream-coloured paper.

No. 13. Mukka-mukka

This consisted of pieces of very light stems of varying diameter, composed of strands of fibrous material embedded in pithy matter.

Chemical examination gave the following results:

	Per cent.
Moisture	13·2
Ash	2·2
Cellulose in material as received	42·2
Cellulose expressed on the moisture-free stems .	48·6

The ultimate fibres measured from 0·6 to 2·8 mm. in length, with an average of 1·5 mm.

In this case also the entire stems, including bark, were treated in the paper-making trials.

Results of Paper-making Trials

Trial.	Caustic soda used. Parts per 100 parts of stems.	Caustic soda used. Parts per 100 parts of solution.	Conditions of boiling. Time.	Conditions of boiling. Temp.	Parts of caustic soda consumed per 100 parts of stems.	Yield of dry unbleached pulp expressed on stems as received.
			Hours.			*Per cent.*
A	20	3	6	160° C.	12·4	36
B	24	4	9	160° C.	14·5	30

The conditions of trial A were sufficient to break up the material fairly well. The unbleached pulp yielded a greyish-brown, very strong paper, showing many dark specks. After bleaching, the pulp gave a buff-coloured, strong paper, which, however, also contained a number of dark particles.

Under the more drastic conditions of trial B the material was more thoroughly disintegrated. The pulp was readily bleached, and then yielded a good white paper free from excessive specks. In this case both the unbleached and bleached papers were of very good strength.

General Conclusions

The results obtained with the thirteen materials, under the conditions found best in each case, are summarised in the following table, the consumption of caustic soda and the yields of pulp being expressed on material containing 12 per cent. of moisture so as to render the figures more readily comparable :

No.	Local Name.	Parts of caustic soda consumed per 100 parts of material containing 12 per cent. of moisture.	Yield of dry unbleached pulp, expressed on material containing 12 per cent of moisture.
		Per cent	*Per cent.*
1.	Bara-bara	14·3	48
2.	Baramalli	13·1	42
3.	Fotui	11·3	53
4.	Haiari-balli	11·4	45
5.	Hubu	15·3	41
6.	Hurowassa	12·5	42
7.	Karahora	12·0	51
8.	Kurukoruru	11·9	43
9.	Long John	13·9	40
10.	Wanasoro	14·3	47
11.	Manicole	15·1	40
12.	Ite (Aeta)	12·8	28
13.	Mukka-mukka	14·6	30

From these results it will be seen that the first ten woods, when treated under suitable conditions, give on the whole good yields of paper pulp. The pulps were found to bleach satisfactorily and in most cases could be used for the manufacture of paper of good quality. Woods Nos. 3, 7, 4, 8, 6 give the best yields of pulp, in the order stated, combined with moderate soda consumption. Nos. 2 and 9 give satisfactory yields of pulp with a rather higher consumption of soda, and Nos. 1, 10, 5 also furnish satisfactory amounts of pulp, but require still more soda.

As regards the remaining specimens, No. 11 would be less valuable than the above ten woods, whilst Nos. 12 and 13 would not be worth exploitation as paper-making materials owing to the low yields of pulp which they furnish. Moreover, in the pulping of Nos. 11 and 13 there is a high consumption of soda, and in the case of No. 12 the paper obtained is of inferior quality.

DAMMAR RESIN FROM PAPUA

An investigation of the characters and uses of a dammar resin from Papua has recently been carried out. The material was supplied by the Director of Agriculture, Papua, who states that the resin is dug from the ground beneath certain trees, which cover a large part of Sudest Island, situated about 180 miles south-east of the mainland of Papua. Botanical specimens of the tree were considered at Kew to be probably a species of *Vateria*, near *V. papuana*, Dyer. Two separate consignments of the resin were received which had the following characters.

No. 1.—This was a small quantity of resin, somewhat stalactitic in form, light brown to pale yellow and mostly transparent, although portions were opaque. It was hard and brittle, and free from foreign matter.

No. 2.—This consisted of a consignment of about 8 cwts., forwarded for the purpose of technical trial. The resin was in irregular pieces, pale yellow to dark brown, and varying in size from pieces weighing about 1½ lb. to fairly fine powder.

The resin was mostly transparent, but the majority of

the pieces were partly or wholly covered with an opaque, oxidised crust. The product was fairly clean, but contained a quantity of extraneous matter consisting of fragments of bark and leaves and some mineral impurities.

The two consignments were chemically examined with the following results :

	No. 1.	No. 2.
Acid value (by direct estimation)	21·4	22·6
Saponification value	32·6	40·0
Ash . . . *per cent.*	0·07	1·4
Melting point	Indefinite, softened at about 115° C and became liquid at about 170° C.	Indefinite, softened at about 120° C. and became liquid at about 160° C.

The clean resin was completely soluble, or nearly so, in turpentine, benzene and chloroform, but only very slightly soluble in alcohol, and partially soluble in ether and light petroleum. The solubility in alcohol could not be improved, as in the case of copal, by first " melting " the resin.

Solutions made with 1 part of resin and 2 parts of turpentine oil, when applied to sized wood gave in each case a hard, almost colourless coat, of fairly good lustre.

The foregoing results indicate that the resin is of good quality and generally similar in character to good commercial dammars, and that it produces a hard varnish of promising character. Unlike most dammar resins, however, the present material is almost insoluble in alcohol and therefore could not be employed for making " spirit " varnishes.

As a result of practical trials carried out by two firms of varnish manufacturers in the United Kingdom the opinion was formed that the material would rank commercially as a " fossil " dammar, and that to render it suitable for varnish making it would have to be subjected to preliminary melting like other fossil resins. It was stated, however, that the material behaved very peculiarly on heating and did not melt in the normal manner ; but the chief drawback was the presence of an appreciable amount of dirt, which made the resin dangerous to work as the dirt accumulates on the bottom of the vessel and local heating may thus take place, causing a flash. If the

resin could be offered in a clean condition it could be utilised commercially, and a nominal value in the United Kingdom of 35s. to 40s. per cwt. was assigned to it. The exact value would depend on the wearing properties of the varnishes prepared from it, and for this purpose exposure tests extending over at least twelve months would be necessary.

The chemical tests and preliminary varnish trials made with this dammar are promising, and it was suggested to the Papua authorities that if the clean resin could be offered in commercial quantities at about £30 to £40 per ton in the United Kingdom an experimental shipment of a few tons should be forwarded for trial sale on the London market. Information has been requested as to the minimum quantity which could be regularly shipped if a demand arose.

It is possible that if the dammar cannot be profitably shipped to the United Kingdom it might be marketed for varnish manufacture in Australia.

DAMMAR RESIN (" DAMAR PENAK ") FROM THE FEDERATED MALAY STATES

THE most valuable, of the dammar resins produced in Malaya is that known as " damar penak " or " damar chengal," obtained from species of *Balanocarpus*, including *B. Wrayii*, *B. Heinii*, and possibly *B. Curtisii*. It is proposed to organise the collection of this dammar in the Federated Malay States with a view to obtaining a uniform product. The collection of the material will be carried out under the supervision of Forestry Officers so as to avoid admixture with other resins and it is intended to establish a number of definite grades. Preliminary experiments have been made in Malaya, and the Imperial Institute has received samples of the resin, separated into seven grades, in addition to two samples (Nos. 8 and 9) of the resin as brought in from the forest. The results of their examination are given in the following pages.

No. 1. *Pale.*—Stalactitic lumps of clean, pale yellow resin, of a maximum length of 2 in. and varying in breadth

from ¾ in. to ¼ in. The resin had a whitish crust, showed a glassy fracture, and contained numerous small bubbles.

The lumps in the other samples were of similar appearance, but varied in colour.

No. 2. *Yellow.*—This was similar to No. 1 except that the lumps were smaller, with a maximum length of 1⅛ in. and a diameter ranging from ½ in. to ⅛ in.

No. 3. *Amber.*—Brownish-yellow resin, in lumps of a maximum length of 1¾ in. and varying in diameter from 1 in. to ¼ in.

No. 4. *Dark.*—Brownish-yellow resin, in pieces ranging from 2 in. long and 1 in. in diameter to ½ in. long and ¼ in. in diameter.

No. 5. *Nibbles.*—Pale yellow resin on the form of small granular pieces about ⅛ in. in diameter.

No. 6. *Coarse.*—Pale yellow resin in the form of coarse powder.

No. 7. *Dust, Fine.*—Pale yellow resin in the form of fine powder.

No. 8. (*A*). *Lumps.*—Clean, pale yellow and yellowish-brown resin, in pieces ranging in length from ¼ in. to 3 in.

No. 9. (*B*). *Chips and Dust.*—Pale yellow resin, in the form of small granular pieces about ⅛ in. in diameter mixed with fine powder.

A noticeable amount of impurity was present in samples 5, 6, 7 and 9.

The amounts of moisture and extraneous matter in the samples are shown in the following table :

Sample.	Moisture.	Extraneous matter.	Resin (by difference).
	Per cent.	*Per cent*	*Per cent*
1.	0·6	0·2	99·2
2.	0·6	0·1	99·3
3.	0·7	0·1	99·2
4.	0·7	0·1	99·2
5.	0·8	0·9	98·3
6.	1·2	2·7	96·1
7.	1·1	2·8	96·1
8.	0·7	0·1	99·2
9.	1·1	2·4	96·5

Chemical examination of the dammars gave the following results :

Sample.	Acid value (by direct estimation).	Saponification value.	Ash.	Softening point.	Temperature of gradual fusion.
			Per cent.		
1.	35·1	39·6	0·01	71° C.	83–95° C.
2.	—	—	0·02	68° C.	82–92° C.
3.	—	—	0·01	70° C.	82–92° C.
4.	34·6	38·1	0·01	80° C.	88–98° C.
5.	—	—	0·38	71° C.	80–90° C.
6.	—	—	1·13	72° C.	82–93° C.
7.	38·3	47·8	1·61	72° C.	80–92° C.
8.	—	—	0·03	73° C.	81–88° C.
9.	—	—	0·54	72° C.	81–90° C.

The foregoing figures indicate that, in general, the resins resemble the East Indian dammars of commerce.

All the samples were completely soluble in turpentine, benzene and chloroform; almost completely soluble in ether; but nearly insoluble in petroleum ether and alcohol. The solubility in alcohol was considerably improved by preliminary "melting," but the resin was not thereby rendered entirely soluble.

Varnish trials were carried out with samples Nos. 1, 4 and 7. Solutions, made with 1 part of resin and 2 parts of turpentine, when applied to sized wood dried to a fairly hard, almost colourless coat, of good lustre. The three resins gave coats generally similar in appearance, that yielded by No. 7 being slightly darker than the other two.

Samples of the dammars were furnished to a number of varnish manufacturers and other firms interested in such resins, together with information regarding the results of their examination at the Imperial Institute. The results showed that this "damar penak" should be readily saleable in the United Kingdom at prices depending on its colour and freedom from extraneous matter. Opinions in the trade appear to differ somewhat as to the desirability of grading the material for the United Kingdom market, and it seems probable that an outlet could be found for both graded and ungraded shipments. The best material, viz. the pale resin represented by sample No. 1, was valued at prices ranging from £140 to £180 per ton. A firm of importers offered to purchase a trial ton of Nos. 8 and 9 combined (the ungraded material) at about £90 per ton c.i.f. Liverpool.

There would appear to be little doubt that if large and regular supplies of the dammar could be shipped from Malaya it would be possible to establish a market for it in the United Kingdom.

"SPRUCE GUM" FROM CANADA AS A SOURCE OF TURPENTINE OIL AND ROSIN

A SAMPLE of oleo-resin, described as "spruce gum," was recently sent to the Imperial Institute for examination. The material was stated to have been obtained in Saskatchewan by tapping white spruce, and it was desired to ascertain its nature and commercial possibilities.

The substance consisted of a sticky, semi-solid oleo-resin, with a strong odour somewhat resembling that of turpentine oil; it was opaque (owing to the presence of moisture) and of a dull cream tint. Some small fragments of bark and wood were present.

Oleo-resin.—The crude oleo-resin as received had the following composition:

	Per cent.
Moisture	4·0
Volatile oil	16·0
Rosin (by difference)	79·5
Dirt (bark and wood fragments)	0·5

Volatile Oil.—The volatile oil was found to have the following constants:

	Per cen.
Specific gravity at 15°/15° C.	0·870
Optical rotation α_D	−7° 15′
Ester value before acetylation	2·0
Ester value after acetylation	4·0

The specific gravity of the oil as shown above is approximately the same as the average for French and American turpentine oils.

The oil was fractionally distilled under atmospheric pressure with the results shown in the following table, which includes for comparison the corresponding figures recorded for American and French turpentine oils:

Fraction boiling at	Oil from "spruce gum." *Per cent.*	American turpentine oil. *Per cent.*	French turpentine oil. *Per cent.*
Below 160° C.	58	74	80 to 90 (below 165°)
160° to 170° C.	32	20	—
170° to 180° C.	8	—	—
Above 180° C.	2	—	—

The fraction of the oil boiling below 160° C. consisted mainly of α-pinene.

Varnishes, prepared by dissolving in this oil (*a*) ordinary rosin (colophony) and (*b*) resins of the copal type, compared favourably with similar varnishes made with American turpentine oil.

Rosin.—The rosin, remaining after the removal of the volatile oil, was freed from extraneous matter by dissolving it in alcohol and filtering the solution. After the removal of the alcohol by distillation the purified rosin obtained was pale brown, transparent, hard and very brittle. It had the following constants, which are shown in comparison with those recorded for commercial rosin (colophony):

	Rosin from "spruce gum."	Commercial rosin.
Softening point	68° C.	70° to 80° C.
Acid value (by direct estimation)	135	151 to 177
Saponification value	147·5	175 to 195

Varnish Trials.—Varnishes, prepared by dissolving the purified rosin in alcohol, when applied to sized wood dried rapidly and produced a pale, lustrous coat, similar to that obtained with ordinary colophony. There was, however, some difference in the viscosity of the two solutions, that made with the spruce rosin being somewhat thinner.

The quantity of oil available was not sufficient for conclusive trials to ascertain its commercial value in comparison with those of French and American turpentine oils. Samples of the oil and rosin prepared at the Imperial Institute were, however, submitted to varnish manufacturers, who reported that though the oil was of good appearance, its odour, which differed from that of the turpentine oils mentioned, would probably limit its sale in competition with these products. The rosin was regarded as equal for ordinary purposes to the "N" grade of American rosin, which was then realising about £14 per ton in the United Kingdom; but the manufacturers stated that this valuation might have to be modified when the material had been tested on a large scale.

The results of this investigation show that spruce

gum is an oleo-resin resembling that which yields the turpentine oil and rosin of commerce. The yield of volatile oil is fairly good, though rather less than the quantity (about 20 to 22 per cent.) usually obtained from the oleo-resins of *Pinus palustris* and *Pinus Pinaster*, from which American and French turpentine oils respectively are principally derived. The oil from the spruce gum resembles the latter products in composition, but it contains a larger proportion of the higher-boiling constituents.

The rosin obtained on removal of the volatile oil by steam distillation is of good appearance, and could be utilised in the preparation of varnishes and for certain other purposes for which colophony is employed; but it could not be employed for making rosin soaps and sizing solutions as it is not sufficiently soluble in aqueous solutions of caustic alkalis.

ARTICLES

THE PROSPECTS FOR TOBACCO CULTIVATION IN KENYA

By C. J. Monson

Lately Tobacco Officer, Department of Agriculture, Kenya

The question is sometimes asked why the production of tobacco has not become an established industry in Kenya, as has been the case in other British territories of the African Continent; and it may be of interest to investigate to some extent the apparent explanation for this lack of development.

Practical farming and planting in this Colony (formerly known as the British East Africa Protectorate) dates only from the beginning of the present century. The early settlers came chiefly from South Africa, where modern methods of tobacco culture had not then been adopted to any great extent, and the British Isles, where at that time the crop was not grown. Here and there a farmer had a slight knowledge of the ready methods practised in South Africa when handling leaf for local consumption, but the highly specialised ways of preparing leaf for a critical market employed in America

and the countries where Turkish tobacco is produced were practically unknown. At the same time the small agricultural population, which has always been of a very intelligent character, realised the difficulty of competing in the world's markets with the experienced planters of the long-established tobacco-producing areas of other countries; and so they turned their attention to other crops which, in comparison, could be more simply handled and placed on the market or seemed to offer a surer investment, *e.g.* wattle bark and coffee and, later, Sisal hemp and flax.

In Southern Rhodesia and parts of South Africa, the Greek immigrant, who originally came to work on railway construction and remained to trade, had a considerable influence in the introduction of Turkish tobacco; but in Kenya, the Indian, who may be said to have come to the Highlands largely for a similar purpose, was but little interested in tobacco growing or any other branch of agriculture. On the coast, tobacco was at one time grown by the Arab population and their slaves, to whose influence the introduction of the coarse tobacco grown by natives in certain parts of the interior may probably be traced. This tobacco, however, bears little resemblance to that now grown on the coast, which consists of attractive, large, light-coloured leaves, and is cultivated by natives in small patches on the islands (especially Patte) and the strip of seaboard near Lamu.

A glance at the meteorological records published by the Agricultural Department, Nairobi, reveals the extraordinary variations in climatic conditions obtaining in the Colony. Speaking generally, a heavy rainfall and high temperatures may be expected in the coastal and Lake regions, whereas, naturally, in the Midlands and Highlands the conditions are more temperate. Frost is unlikely to be experienced at a lower altitude than 6,000 feet. Throughout the Highlands, however warm the days may be, the nights are usually cool; and during a period (July–August) between the so-called " long " and " short " rains, quite cold weather often occurs.

The soils of the country are equally varied, and this is particularly marked as regards those suitable for

tobacco, which are very scattered. So far as present knowledge shows, such soils are more frequently to be found in small rather than large tracts.

It will be readily understood that, as a result of these variations, the experience gained in one district may prove of but little value in another, even though these may not be far apart. This renders the investigation of the prospects throughout the country for the introduction of a new crop an extensive and lengthy proposition. Especially is this the case when dealing with so sensitive a plant as tobacco.

The fungal diseases and insect pests attacking vegetation are numerous and widely distributed, as is usual in what may be termed an " untamed " country. Though knowledge of host plants and preventive measures grows daily, the need for further scientific research is very evident, the many unexplored problems concerning such pests being of vital importance from an economic point of view.

Kenya is not at present financially rich ; her agricultural population consists almost entirely of those who have to gain their wealth by their own efforts, and funds for none but the most essential and promising experiments have been available. The opinion has been commonly held that trials which may not yield prompt returns should be largely, if not entirely, the work of Government, and, so far as means have allowed, the Department of Agriculture has endeavoured in the past to meet these requirements as they became apparent.

Co-operative experiments started by the Department with individual planters have not infrequently come to a premature conclusion through the departure of the planters from the Colony. Again, the appearance of a seemingly more promising industry has induced some to abandon valuable trials.

In the early days of the Department, a Tobacco Officer was appointed for Kenya and Uganda jointly, but this arrangement did not long continue, as the officer reported Uganda to be the more promising territory for tobacco cultivation, and he was, in consequence, detailed for duty in that Protectorate solely. The tobacco tried seems to

have been of a class intended for cigars, and for some years a settler in the Highlands continued the endeavour; climatic conditions in this region, however, do not appear to be suitable for the production of this class of leaf and no very satisfactory results are recorded.

Following a desire expressed by agriculturists, including among others the Coffee Planters' Association, Kyamba, that attempts should be made to discover new crops which could be cultivated in case of the failure of those already grown, the Department of Agriculture, which had then been reorganised under a new Director, made provision for further tobacco trials, and serious work was commenced with these in 1912.

It was deemed advisable that these experiments should, in the first instance at any rate, be confined to the areas already settled by Europeans where some facilities might exist and the information gained be of immediate value, rather than to commence in unoccupied areas where possibly the conditions were more suitable for tobacco. For this reason the Tobacco Officer was stationed at the Department's Experiment Farm at Kabete, and instructed to carry out trials there on the forest soil, typical of the Kikuyu country, which had become an established coffee area. This was in accordance with the desire of the coffee growers to which allusion has been made.

For reasons previously explained it was very important to extend the scope of the experimental work through as many districts as possible; limited staff and funds prohibited the Department from undertaking the whole of these trials, but endeavours were made, by means of visits to those interested and by distributions of seed, sets of flue pipes, and general advice regarding the methods of cultivation, curing and handling the crop which were considered best for Kenya conditions, to induce planters in several districts to start small co-operative trials.

Among the most encouraging of these was a crop of seven acres of light American tobacco on an estate owned by a Company in the Kibwezi District of the Midlands. The leaf grew quickly and well, and was of good appearance in the field; but, unfortunately, the owners were not prepared to provide a flue barn, so the leaf had to be sun-

cured in the Turkish manner and handled in a rough-and-ready way, such facilities as were available being utilised. Samples of the cured leaf were examined at the Imperial Institute, where it was found that the tobacco burnt easily and evenly in cigarette form, leaving a grey ash. The flavour was mild and the aroma free from pungency and not very pronounced. The tobacco was of good colour, low in nitrogen and rich in potash. A firm of tobacco manufacturers considered that the tobacco was of very good colour and appearance and of smooth texture, whilst the report of a second firm stated that it was "a very pretty sample of light mahogany wrapper with wide spreading leaves of moderate length. The leaf smells like Turkish tobacco. The flavour is mild and somewhat insipid. The tobacco burns well without much aroma."

To the regret of the Department of Agriculture, the owners of the property where this trial took place decided to discontinue growing tobacco in favour of another crop.

Probably the next most interesting co-operative trial was on the sandy " wash " soil at the foot of hills near the Athi plains at the commencement of the Highlands, where the brightest American flue-cured leaf as yet produced in the Colony was obtained. A striking feature of this trial was that, owing to the nature of the soil, a rainfall of but 13 inches from seed to harvest was sufficient for the crop. Then came the war, and these district trials came to an end.

To return to the Departmental work at Kabete. In 1912 an area of 13 acres was planted with five varieties of American light, three American heavy, four Turkish and one local tobacco. Barns were built both for flue and air curing, and sun-curing racks were erected for the Turkish leaf. These trials were continued during the years 1913 and 1914, when 10½ and 6 acres respectively were planted. The latter year was not favourable for tobacco culture, and the results for that season were of little value. A few acres were planted in 1915 and then the proper experimental work had to be abandoned. Varieties of the class suitable for cigar wrappers and fillers were included in the later trials.

The cured leaf from these plots indicated that the forest soil at Kabete was too rich for tobacco. Great

difficulty was experienced in curing the leaf to desirable colours and the flavour was disagreeably strong. Samples were sent to the Imperial Institute and the results of examination confirmed these conclusions and advice was given to try to mitigate this quality in the soil by crop rotation. This was tried, but the leaf obtained was still unsatisfactory.

"White mildew," or rust, attacked all the varieties, the Turkish being most affected; indeed, this disease apparently prohibits the successful production of Turkish leaf in the Highlands and Midlands. It was found possible, however, to control the disease on the American tobacco.

Before the Departmental work had to be abandoned, investigations and small trials at the Coast had been started and fairly favourable indications resulted. Later reports on private crops lead to the conclusion that tobacco may prove a success in the coastal strip. This would seem to receive support by the appearance of the natives' tobacco of which mention has already been made.

Subsequent to the war the Departmental vote for tobacco was cut down to a small figure and later the Tobacco Division was abolished for reasons of economy.

It is impossible to review the trials in every district in this article; judging generally from present experience there should be a future for the crop in the lower Highlands and the Midlands where suitable light soil is to be found.

The results of the initial trials which are recorded in the Reports of the Agricultural Department should prove of value when further systematic investigations are attempted, and there seems reason to hope that the agricultural community will not allow tobacco growing to be dropped altogether.

The difficulty in maturing and handling small quantities of tobacco where the limited area of the trial provides but small bulk of leaf and in making such into consignments for commercial purposes will be easily understood. If it were possible to provide a local warehouse to which farmers could send leaf for the market, it would undoubtedly have a most encouraging effect. A further hindrance to progress is the ignorance of the farmers concerning the requirements of the overseas market.

THE PRESENT POSITION OF SISAL HEMP CULTIVATION, WITH SPECIAL REFERENCE TO THE BRITISH EMPIRE.[1]

BY ERNEST GOULDING, D.SC. (LOND.), F.I.C.
Superintendent of Investigations, Imperial Institute.

THE well-known cordage fibre, Sisal hemp, is derived from the leaves of certain species of Agave. The name is now usually restricted to the product of *Agave sisalana*, Perr. (*A. rigida*, Miller, var. *sisalana*), although it was first applied to the fibre produced in Yucatan, Mexico, mainly from the leaves of *A. fourcroydes*, Lem. (*A. rigida*, Miller, var. *elongata*, Jacobi). The latter fibre is commonly distinguished as "Henequen," or "Mexican Sisal."

The true Sisal hemp plant is a native of Central America, but has been introduced into most tropical countries, including Florida, the West Indies, South Africa, East Africa, West Africa, Madagascar, Mauritius, India, Indo-China, the Dutch East Indies, the Philippine Islands, the tropical parts of Australia, Papua, Fiji and Hawaii.

The earliest efforts to introduce the fibres into commerce were concerned with henequen and were made in Mexico in 1839. It was found, however, that the preparation of the fibre by the primitive methods then employed were so slow and tedious that even with the cheap labour available the cost of production was discouraging. Some years later a simple machine was invented, and its employment led to a gradual expansion of the industry.

It is estimated that the annual production of fibre in Mexico is now about 150,000 tons when the plantations are working at their full capacity. A large proportion of the product (probably over 90 per cent.) is exported to the United States, where it is employed for the manufacture of the binder twine used in harvesting the immense grain crops of the Western States. The present demand for binder twine for this purpose amounts to about 200 million lb. annually. The output of fibre from Mexico has not been seriously reduced by the political and military disturbances of recent years, but during the latter half of

[1] A paper presented at a Conference held in connection with the Sixth International Exhibition of Rubber, Other Tropical Products and Allied Industries, Brussels, April 1924.

1923 transport difficulties occurred owing to the revolution and the occupation of the country by the rebels, and exports temporarily ceased. As a result of the uncertainty of Mexican supplies, European manufacturers have turned their attention to African Sisal hemp, and it is probable that they will continue to use this in preference to the Mexican product unless substantial advantages are offered. In any case, it is unlikely that in future there will be much Mexican fibre available for the European market after the needs of American consumers have been fully met.

It is evident that in order to ensure a sufficient supply of Sisal hemp for the needs of European manufacturers, the production in countries other than Mexico should be greatly increased and the industry introduced if possible into new regions.

It has therefore been considered of interest to give a brief account of the efforts which have been made to establish Sisal hemp cultivation within the British Empire, together with an indication of the present position and prospects of the industry in each of the countries in which the growth of the crop has been attempted.

It will be seen that the only British countries at present producing the fibre on an extensive scale are East Africa (Kenya and Tanganyika) and the Bahamas, but that commercial supplies may be expected in the near future from Ceylon, Nyasaland, Gold Coast, Mauritius and Jamaica. Several other countries are well adapted to the crop and have extensive areas available for cultivation.

The results of the attempts to develop a Sisal hemp industry in these various countries have confirmed the view that the crop cannot be profitably produced unless the operations are carried out on a large scale and with the employment of modern machinery. As one extraction machine is capable of preparing from 500 to 600 tons of fibre per annum and the average production of the fibre is about 1 ton per acre, it is evident that an area of from 500 to 600 acres of mature plants must be annually available for each. As the plants take some years to come to maturity and are only available for cutting for a limited period, it is obvious that fresh areas must be planted in

succession in order that the machines may be continuously supplied. This question need not be considered in fuller detail as an excellent discussion of the subject has been published by Major L. A. Notcutt, M.C., A.R.S.M., in a supplement to the issue of *Tropical Life* of April 1923. Major Notcutt, who has had considerable experience of Sisal hemp growing in Portuguese East Africa and has also studied the question in Kenya and Tanganyika, recommends the planting of a fresh section of 600 acres each year, and suggests a scheme which would involve the planting of a total area of 7,200 acres and the installation of six extraction machines. This he considers should be regarded as the minimum scale of operations for the establishment of a profitable industry.

East Africa

Tanganyika.—The Sisal hemp plant was introduced into German East Africa (now Tanganyika) in 1893. In that year the German East Africa Company ordered 1,000 plants from Florida, but only 62 of them survived the journey. These were carefully tended in a plantation at Kikogwe, and new plants were propagated from them so that in 1898 the number had increased to 63,000. In 1899 machinery was introduced for extracting the fibre. By the beginning of 1900, no less than 150,000 plants had been established, of which 4,000 were more than three years old and were ready for cutting. The first shipment of fibre was made in 1900 and amounted to 7½ tons. From this time forward the industry progressed with remarkable speed, as is shown by the following statistics of exports (in metric tons) during the years 1905–1913:

1905	1906	1907	1908	1909	1910	1911	1912	1913
1,397	1,854	2,830	3,897	5,284	7,228	11,213	17,079	20,835

In 1912 the total area planted with Sisal hemp amounted to 61,162 acres.

The industry was seriously affected by the war, and on the establishment of British administration in 1920 it was found that many of the best plantations had undergone serious deterioration. The situation is being gradually retrieved, but some years must elapse before the industry has fully recovered its pre-war position.

The exports in 1922 amounted to 10,224 tons, of which the greater part was shipped from Tanga and a small quantity from Lindi. Of this amount, about 48 per cent. was consigned to the United Kingdom, 25 per cent. to the Continent of Europe and 25 per cent. to the United States. There is no doubt that the production will rapidly increase. Standard grades have now been established and this policy has facilitated the marketing of the crop by increasing the confidence of importers.

The Sisal hemp produced in Tanganyika is of excellent quality and realises the highest prices, being usually quoted at about 10 per cent. in advance of Mexican Sisal.

Kenya Colony.—The cultivation of Sisal hemp in British East Africa (now Kenya Colony) was begun in 1903, trials being first made in the Nairobi District and a little later in other parts of the country. Excellent results were secured and the encouragement thus obtained led to a gradual extension of the industry. It was found that plants grown at the coast yielded a higher percentage of fibre than those grown in the Highlands and also furnished a finer fibre, but that in the Highlands a larger yield per acre was obtained and the cost of labour was less. In 1913 about 7,000 acres had been planted ; in the year 1913–14 the exports of fibre amounted to 1,073 tons and in the following year to 1,681 tons.

In 1916–17 there were about 15,000 acres devoted to the crop, whilst in 1921 the area had more than doubled, amounting to no less than 31,050 acres, distributed as follows : *Kenya Province.* Fort Hall, 8,924 acres. *Naivasha Province.* Eldama Ravine, 500 acres ; Naivasha, 648 acres ; Trans Nzoia, 607 acres ; Uasin Gishu, 4 acres. *Nyanza Province.* Kisumu, 2,304 acres. *Seyidie Province.* Malindi (Kilifi), 1,340 acres ; Mombasa, 1,600 acres ; Vanga, 1,080 acres ; Voi, 2,288 acres. *Ukamba Province.* Kikuyu (Kyambu), 3,465 acres ; Machakos (Ulu), 7,737 acres ; Nairobi, 553 acres.

In 1922 the total area increased still further to 37,118 acres and the production for the year ending June 30, 1922, was 4,677 tons.

The greater part of the Sisal hemp produced in Kenya

is exported to the United Kingdom. Improvements made in the last few years in the organisation and management of labour and the increase in the output of the factories have effected considerable economies in the cost of production; and these factors, in conjunction with a lowering of the transport rates, have enabled the industry to be carried on profitably even when the market prices of the fibre are comparatively low.

There is a vast area of land in Kenya which is well adapted for Sisal hemp growing, and the further expansion of the industry depends chiefly on the introduction of capital and the supply of the necessary labour.

Uganda.—Sisal hemp plants have been grown with success in the Botanic Gardens at Entebbe and a sample of fibre forwarded to the Imperial Institute was of excellent quality. There are enormous areas in Uganda which would doubtless be well suited to the production of the fibre on a large scale.

Nyasaland.—Sisal hemp has been found to grow well on loose sandy soils in all parts of Nyasaland, but the cultivation of experimental plots at various altitudes in the Protectorate has shown that the best results are obtainable at elevations not exceeding 2,500 ft. The industry is now being carried on as a commercial enterprise and the outlook is very promising.

In the Ruo District, Sisal hemp is being grown on the lower levels between Sankulani and Chiromo. Large plantations have been established at Chiromo and considerable success has been achieved. It was reported in 1922 that 100 tons of fibre had been exported from these estates and that very favourable reports had been received regarding the quality of the product. The factory is run entirely by water-power, and the power available is sufficient to admit of operations on a much larger scale. It is anticipated that the production of fibre will be greatly increased.

In the Lower Shiré District there is a Sisal hemp plantation of about 1,000 acres which is situated about 4 miles above Port Herald and has recently reached the producing stage.

Zanzibar.—The Sisal agave thrives well on the islands of

the Zanzibar group and fibre from this source has been favourably reported on.

Mauritius.—This island is well known as the source of Mauritius hemp or "aloe" fibre, derived from the leaves of *Furcræa gigantea.* The production of this fibre forms an important industry which has been in existence for about fifty years.

As the Sisal agave furnishes a product superior to the ordinary Mauritius hemp and also usually gives a higher percentage of fibre from the leaves, it seemed not improbable that its cultivation might prove more profitable than that of Furcræa. Some years ago, therefore, certain areas were planted with Sisal in order to compare the possibilities of the two crops. In general, these Sisal plantations gave favourable results, although in some cases the growth was irregular. The fibre produced was of good quality, and small quantities which were exported realised satisfactory prices in the European markets. It was found, however, that the Sisal plantations required more attention in the early stages of growth than the Furcræa plantations.

Continued interest is being taken in the substitution of Sisal cultivation for that of Furcræa. A planter in the north of the Island has established a plantation of about 300 acres and has imported machinery for extracting the fibre.

West Africa

Nigeria.—The Sisal agave has been grown on a small scale by the Department of Agriculture at Ilorin and at Old Calabar, and the results have proved that the cultivation can be carried on satisfactorily. It was stated, however, by the Director of Agriculture of the Northern Provinces (Mr. P. H. Lamb) in 1919 that as the production of Sisal hemp on a commercial scale is adapted to large planters rather than to the small cultivator it is unlikely that any considerable development will take place.

Sierra Leone.—Trials have also been carried out successfully in Sierra Leone and a sample of fibre which was forwarded to the Imperial Institute in 1907 was found to be of promising quality. Recent experiments on the Government Farm at Batkanu have given good results

and considerable interest has been aroused among the chiefs and the people of the district. Trials are also being conducted at the Njala Experiment Station, and a simple form of machine has been erected for extracting the fibre.

Gold Coast.—An interesting experiment in Sisal growing is now being carried out by the Government of the Gold Coast. During the German occupation of Togoland large plantations of Sisal hemp were created, two of which subsequently came under British administration. These plantations proved so successful that in 1920 it was decided to plant an area of 1,000 acres on a site a few miles west of Accra with the object of demonstrating that the dry plains at present lying waste in this region can be profitably cultivated. The plantation is intended to serve as the centre of an industry which it is hoped will be adopted by the native farmers as soon as they have appreciated the value of the crop. A central factory has been erected and equipped with modern fibre-extracting machinery. The Government are under agreement with the local chiefs to hand the plantation and machinery over to them when the capital outlay has been recovered and when they have proved themselves competent to carry on the enterprise.

The climatic and other conditions of the district seem to be well suited to the crop as the plants have grown satisfactorily and present a healthy appearance. It was anticipated that leaves would be ready for cutting during the present year (1924). The local farmers are being encouraged to plant Sisal hemp, especially in the neighbourhood of the Government plantation, and advice and assistance are being freely afforded to them. As an additional inducement, the Government are planning a series of tramways radiating from the central factory with a view to facilitating transport of the leaves from the native farms. There are many miles of country suitable for the cultivation and it is hoped that an extensive industry may eventually be created.

Sisal hemp has also been grown experimentally at the Tamale Agricultural Station in the Northern Territories and at other agricultural stations, and successful results have been obtained.

South Africa

Union of South Africa.—Comparatively little attention has been devoted to Sisal hemp in South Africa, although the Mauritius hemp plant (*Furcræa gigantea*) has been grown on a small commercial scale in Natal.

Trials made with Sisal hemp in the Union have indicated that the most suitable situations for plantations are lowlands near the coast, or waste lands at altitudes not exceeding 1,800 ft.—where the atmosphere is warm and humid and where only slight variations in temperature occur.

A survey of the coastal districts with reference to the possibilities of establishing a fibre industry was made in 1917 by Mr. E. Holmes-Smith, B.Sc., at the request of the Secretary for Agriculture. The results indicated that, in general, the whole of the coastal area from the Transkei to Mossel Bay offers great possibilities for Sisal cultivation, and it was suggested that experimental plantations should be made in the vicinity of Kei Bridge (Transkei), East London, Kingwilliamstown, Port Elizabeth, Uitenhage or Humansdorp Districts, Knysna, and George. Abundant supplies of water and fuel, cheap labour and ready means of transport are available at all these places.

South-West Africa.—Trials in Sisal hemp cultivation are now being made in the mandated territory of South-West Africa, and a sample of fibre grown at Rietfontein on the border of Bechuanaland has recently been received at the Imperial Institute and found to be of good quality.

Rhodesia.—In Northern Rhodesia there are large areas in which the soil and climatic conditions appear to be favourable for Sisal hemp cultivation and which offer good opportunities for the production of the crop on an extensive scale. In 1912 trials were carried out at the Chilanga Experimental Gardens and at Mazabuka. The plants grew well and the leaves gave a satisfactory yield of fibre. A sample of the fibre produced at Chilanga was received at the Imperial Institute in 1917 for examination and was found to be rather short but otherwise of excellent quality.

Experiments have also been made in Southern Rhodesia but have not given very encouraging results. Although

the plants grew fairly well, the leaves developed rather slowly and did not become sufficiently large to yield a fibre of good length.

ASIA

India.—The production of Sisal hemp in India has not assumed important dimensions although attempts to cultivate the crop on a commercial scale have been made in Assam, Bombay and Southern India, and fibre has been extracted from plants growing beside the railway in the Coimbatore District, Madras. In the Central Provinces, *Agave Cantala*, the source of the "maguey" fibre of the Philippines, a product resembling Sisal hemp, is grown to some extent as a hedge-plant but comparatively little fibre is extracted. During recent years some attention has been given to Sisal hemp in Burma, but no large quantities of fibre have yet been produced.

In Mysore several species of Agave are planted as hedges, but these are not of much value as a source of fibre. The true Sisal hemp plant was introduced in 1892 and has been cultivated to some extent in the Lal Bagh Gardens in Bangalore. Efforts are being made to grow the crop on a commercial scale in Mysore, but no results of importance have yet been obtained. Just outside the borders of the State in Coorg, however, a small plantation of Sisal hemp has been worked successfully for several years.

Ceylon.—Sisal hemp was grown for several years by the Department of Agriculture of Ceylon at the Maha Iluppallama Experiment Station in the North Central Province and satisfactory results were obtained. In 1918 this Station was closed, but with a view to continuing the experiments and extending the cultivation a syndicate was formed which was granted a concession of 2,200 acres of Crown Lands on special terms. Work was started in 1919 and good progress has been made. Fibre of excellent quality has been produced, and it is considered that with the introduction of efficient machinery a product will be obtainable on a commercial scale which should compare favourably with that from any other source. From the results already obtained at Maha Iluppallama it has been estimated that the cost of production of the fibre should

not exceed £10 to £12 per ton. There are good grounds for anticipating that the enterprise will be fully successful and, if such should be the case, it is probable that the industry will undergo great expansion as there are vast areas available in the dry zone of the Colony which are at present uncultivated and would be quite suitable for Sisal hemp.

The Agricultural Department is convinced that Ceylon offers great possibilities for fibre production, and since 1918 has had areas of Sisal under cultivation at Anuradhapura, where a small mill has been established for extracting the fibre. The Department is also undertaking small experimental trials at Jaffna and Hambantota, in the extreme north and extreme south of the island respectively. Large numbers of plants have been distributed, mainly to the Southern Province and the Kurunegala District of the North-Western Province.

Federated Malay States.—There is no doubt that Sisal hemp can be grown satisfactorily in the Malay Peninsula. The Department of Agriculture have grown the plant experimentally for some years and recently interest has been taken in the crop by planters, and it is now being cultivated on a small scale on three estates. The necessity of growing the crop on a sufficiently large scale to justify the introduction of modern extracting machinery has hitherto militated against the establishment of the industry on commercial lines.

North Borneo.—The climate and soil of North Borneo are admirably suited to Sisal hemp cultivation, and some of the comparatively dry areas in the interior near the terminus of the railway are particularly favourable for the crop. Hitherto the plant has been grown only on an experimental scale, but it is considered that the country offers excellent possibilities for the establishment of a successful fibre industry.

West Indies

Bahamas.—The Sisal hemp plant has long been acclimatised in the Bahamas, but was not seriously regarded as worthy of systematic cultivation until 1888, when the Governor of the Islands (Sir Ambrose Shea) took steps to

encourage the establishment of a local fibre industry. During the next few years several large undertakings purchased extensive tracts of land and planted them with the Sisal agave. The rapid growth of the industry is shown by the following data of the quantities and value of the fibre exported in certain years :

Year.	Quantity. Tons	Value. £	Year	Quantity Tons	Value £
1891	9	149	1912	3,000	66,427
1892	30	692	1915	3,453	72,601
1893	52	1,200	1916	3,739	114,465
1894	79	1,728	1917	3,349	181,695
1895	242	3,987	1918	2,607	128,564
1897	402	4,522	1919	2,830	85,131
1899	607	16,942	1920	1,940	51,329
1903	1,439	38,805	1921	108	2,242
1906	1,726	40,140	1922	1,156	23,000
1909	2,610	48,805			

The whole of the fibre exported from the Bahamas enters the United States.

In 1917–18, as a result of the increased prices due to the war, the plantations were considerably extended. In 1918 a system of grading of the fibre was introduced and a special Inspector was appointed. The packing houses have co-operated with the Inspector and there is no doubt that the grading has led to an improvement in the standard of the hand-cleaned fibre. In 1921 the American demand ceased for the greater part of the year and export was suspended. During 1922, however, all the stocks which had been stored were disposed of and the industry exhibited signs of renewed activity.

The production of Sisal hemp has proved of much value to the Bahamas, and, owing to the resistance of the crop to drought, it has been of great financial assistance to the people at times when other crops have failed.

Jamaica.—Sisal hemp plants were introduced into Jamaica from the Caicos Islands in 1886 and planted at Hope on an area of 30 acres. This attempt, however, resulted in failure as the plants poled when they were about two years old and died before the leaves were ready to be cut. In 1891 plants were procured from Florida and were cultivated in Vere, but, owing to a decline in the market price of the fibre, the enterprise was abandoned. Later

efforts have proved that the crop will grow well in Vere when planted on limestone soils.

The henequen plant (*Agave fourcroydes*) was introduced into Jamaica from Yucatan about seventy years ago and plants have been growing freely in several districts. Observations made on plants growing in the Botanical Gardens showed that this crop can be cultivated with success on dry alluvial soils.

Experiments carried out more recently at Lititz (Southern St. Elizabeth) and at Hope (near Kingston) have confirmed the above results as regards the types of soil best suited to the Sisal and henequen plants. By March 1919 the Department of Agriculture had planted 500 acres at Lititz on land which was regarded as useless for other crops.

Samples of Sisal hemp and henequen fibre produced at both Lititz and Hope were examined at the Imperial Institute in 1919 and found to be of promising quality.

In 1921 it was reported that 4,000 acres had been planted in Jamaica with Sisal hemp, 3,000 of which were situated in the neighbourhood of May Pen, in the parish of Clarendon, where two factories had been erected. A private factory was also stated to be at work at Hodges Pen in St. Elizabeth. Some hundreds of acres were nearly ready for cutting on the Government Plantation at Lititz and a factory had been established at the northern extremity of the plantation, so that the adjacent lands which are in private possession might be planted with Sisal hemp and the leaves sold to the factory on a co-operative basis.

There are about 1,000 acres of land within two miles of the factory which are well adapted to the crop, and, in 1921, 200 acres of this had already been planted by one of the landowners.

The Lititz authorities offered to advance £2 per acre for approved plantations to be established within three miles of the factory.

In 1922 there were 1,141 acres devoted to the crop at Lititz. The factory, which is equipped with English machinery, commenced operations in that year and 50 tons of the fibre produced was sold at the market price then

ruling for the highest quality. There is, therefore, no doubt that the savannah lands of Lititz are capable of yielding excellent fibre. The new industry has been of great advantage to the people of Lititz, many of whom would otherwise have suffered severe privations during periods of drought.

Fibre was also manufactured in 1922 at three factories in Clarendon, and a Sisal rope-making factory was started by private enterprise at May Pen.

Cayman Islands.—The Sisal hemp plant grows readily in the Cayman Islands and a few years ago consideration was given to the possibility of creating a local fibre-growing industry. It was soon realised, however, that development was precluded by the high price of suitable land and by the impracticability of obtaining the necessary labour at a reasonable cost.

Caicos Islands.—The Sisal hemp plant was introduced into the Caicos Islands from the Bahamas about the middle of the nineteenth century, but it was not seriously cultivated until 1890. Two companies were formed in that year which established plantations in West Caicos, and at Breezy Point, East Caicos. Several private plantations were already in existence and a small shipment of fibre from one of these to New York realised a price equal to that of the best Yucatan fibre. Subsequently the two companies extended their operations and introduced machinery for preparing the fibre. The industry proved of great value to the Colony by giving employment to the people and thus affording them much assistance when other crops failed owing to drought.

During the years 1899–1906 the value of the annual exports of Sisal hemp ranged between £5,000 and £7,500. In 1906 the areas devoted to the crop were as follows: East Caicos, 2,000 acres; West Caicos, 1,000 acres; Bellevue, North Caicos, 150 acres; Haulover, Grand Caicos, 50 acres; total, 3,200 acres. Subsequently great fluctuations occurred in the quantities of fibre annually exported owing to several causes, including the hurricane of 1908 and variations in the market price of the product. In 1912 the West Caicos Company went into liquidation, and in 1918 the East Caicos Company decided

to cease operations and no effort was made to replant or to open up new areas. In 1920 the industry was abandoned.

Various reasons are given for the failure of this industry, which for some years showed such great promise and is so well suited to the climatic conditions of the islands. It is considered, however, that the chief cause was connected with transport difficulties, and the opinion has been expressed that until some means can be found to make direct shipments to the United Kingdom, instead of through New York, neither Sisal hemp nor any other industry can be successfully developed.

Antigua.—Attention has been directed to the question of the cultivation of Sisal hemp on a commercial scale in this island, and in recent years steps have been taken to establish plantations. It was anticipated that extensive areas would eventually be devoted to the crop.

British Guiana.—Sisal hemp grows well on the coastal lands of British Guiana and there are many places suited for the development of the cultivation.

The first important trial of Sisal hemp in the Colony was carried out at Cole's Glen on the Demerara-Essequibo Railway. The plants grew very well at first, but later the plantation unfortunately had to be abandoned owing to a severe outbreak of the leaf disease, *Colletotrichum Agaves*, which caused the destruction of nearly all the plants.

Subsequently over 250 acres were planted with the crop on an estate situated on the Mazaruni River, and a factory was erected and equipped with machinery for fibre extraction. Excellent fibre was obtained, but, owing to the high cost of production, due to labour conditions, the enterprise was not a financial success. This plantation also became attacked by the leaf disease, and the industry was abandoned.

British Honduras.—Attempts have been made to grow Sisal hemp at the Botanic Station, British Honduras, and a sample of fibre prepared from plants grown at this station and forwarded to the Imperial Institute was of excellent quality and regarded by experts as equal to prime British East Africa fibre.

AUSTRALASIA

Experiments with Sisal hemp have been carried out in many parts of Australasia, and there is no doubt that there are large areas in Northern Queensland, the Central Province of Papua, the Northern Territory and the north of Western Australia which are well adapted to the crop.

Queensland.—In 1904 special attention was directed to Sisal hemp cultivation in Queensland and a few acres were planted by the Department of Agriculture at the penal establishment at St. Helena with a view to the production of planting material. Between 1904 and 1910 hundreds of thousands of suckers and bulbils were distributed to intending growers in many parts of Queensland, Papua, Fiji, the Solomon Islands and other countries.

At one time there were prospects of the establishment of a large Sisal industry in Queensland, but the high wages now required for labour and the increased cost of machinery have rendered it impossible for the fibre to be profitably grown and the cultivation is therefore no longer recommended by the agricultural authorities.

Mr. T. H. Wells, who has produced Sisal hemp with considerable success on his estate at Farnbro, Childers, in Queensland, has made some interesting suggestions for the cultivation of the fibre in Australia by communal planting (*United Empire*, 1917, vol. viii, p. 551). He proposes that co-operative settlements should be formed in which each planter should contract to supply the leaves produced on 30 acres to a central mill in which the fibre would be extracted and prepared for the market.

Northern Territory.—The Sisal hemp agave was first introduced into the Northern Territory in 1891. During the years 1907–9 the Government endeavoured to create a fibre-growing industry. Considerable interest was aroused and a large number of plants were distributed, but the interest soon disappeared and only a small proportion of the plants was ever planted out of the nursery beds. Excellent fibre was produced from plants growing in the Botanic Gardens at Palmerston and there is no doubt that the country is well suited to the crop.

During 1912 another attempt was made; about 5,000 plants were distributed and a small bounty was offered for a few years in order to establish the industry. This attempt also failed owing chiefly to the high cost of labour in the Territory.

Papua.—In the Territory of Papua, New Guinea, *Agave sisalana* has been grown with excellent results. The region which appears best adapted to the industry is the "dry belt" district of Port Moresby, a narrow strip of limestone country about 100 miles long, which extends along the south coast from Hall Sound to Hula and has an annual rainfall of from 27 to 42 in. Planting commenced in this district about the year 1907, and in 1909 the area under the crop amounted to 382 acres and had increased by 1910 to 1,131 acres. The first recorded exports were made in 1910–11 and were of value £340. In 1913–14 3,110 acres were devoted to the crop and 142 tons of fibre, of value £3,633, were shipped. The exports of Sisal hemp from Papua during the years 1917–18 to 1921–22 were as follows:

Year	Quantity	Value.
	Tons.	£
1917–18	343	17,682
1918–19	287	12,352
1919–20	336	12,284
1920–21	188	7,723
1921–22	145	4,630

It will be seen from these figures that, although a promising industry was established, the success of the enterprise has not been maintained. In 1920–21 it was reported that there were only three important Sisal plantations in the Territory, of total area 5,857 acres, and that these were not being developed with any enthusiasm. In the following year it was stated that the industry was no longer profitable owing to the low prices ruling for the fibre and the high cost of transport, and that the plantations had a very neglected appearance. Very little fibre was being produced, and the exports had therefore declined.

Solomon Islands.—Experiments have been made to determine the possibilities afforded by the Solomon Islands for Sisal hemp production, but the results have led to the

conclusion that the climate is too damp for the crop to be grown successfully.

Fiji.—Experiments in Sisal hemp growing were commenced in Fiji in 1906 and favourable results were obtained by the Department of Agriculture at the Nasinu and Lautoka Experiment Stations, situated respectively in the wet and dry regions of the island of Vitilevu; but the dry zone was found to be best adapted to the crop.

There is much land in the Colony available for Sisal hemp which is unsuited to the cultivation of other products, and in 1912 a considerable area was leased to planters for its cultivation. It was anticipated that the production of the fibre would become an important industry, but the crop has never assumed any great dimensions, and in 1923 it was reported that on only one plantation was it being grown on a large scale. The following exports have been recorded: 1912, 8 tons; 1913, 8½ tons; 1914, 15 tons; 1916, 5½ tons; 1917, 17 tons; 1918, 4 tons; 1919, 6½ tons; 1922, 8 tons.

The yield and quality of the fibre are quite satisfactory, and the industry would be capable of considerable expansion if the labour shortage could be permanently overcome.

NOTES

Imperial Institute Monographs on Mineral Resources.—Two new volumes in this series of monographs have recently been issued by Mr. John Murray, dealing respectively with *Cobalt Ores* and *Vanadium Ores*.

Cobalt Ores, by Edward Halse, A.R.S.M., M.Inst. M.M., of the Scientific and Technical Department, Imperial Institute, contains 54 pages, and is published at 3*s.* 6*d.* It describes the cobalt minerals and ore deposits; the mining, concentration and metallurgy of cobalt; and the properties, value and production of the metal. The cobalt deposits of the British Empire, *e.g.* Ontario, India, Transvaal, New South Wales and Queensland (Cloncurry), are described in some detail, whilst the foreign sources of supply, such as the deposits of New Caledonia, Czecho-Slovakia, Germany, Scandinavia, Transcaucasia, Belgian Congo, United States, Chile and Peru, are also dealt with. A sketch map shows the principal cobalt occurrences in the world, and the monograph concludes with a list of references to literature on cobalt.

Vanadium Ores, which has been prepared by members of the Scientific and Technical Staff of the Institute, consists of 72 pages, and is published at 5*s*. Vanadium minerals and their occurrences are dealt with as well as the metallurgy of vanadium, and the uses, world's production, and prices of the metal. A description is given of the vanadium deposits of the British Empire, including those of Northern Rhodesia, South-West Africa, Transvaal and South Australia, and, as regards the foreign sources of supply, the principal vanadium deposits of Peru (Minasragra) and of the United States (Colorado, Utah, Pennsylvania, New Mexico and Arizona) are described, as well as the occurrences of France and Luxemburg, Spain, Mexico, Argentina, Chile and other countries. A sketch map, indicating the chief vanadium deposits of the world, and a list of references to the literature of the subject are provided.

British Empire Exhibition.—The Imperial Institute is taking part in several directions in connection with this exhibition, and the following particulars may be of interest.

Imperial Institute Section.—An exhibit has been arranged in H.M. Government Pavilion, illustrating the work of the Scientific and Technical Department and the Technical Committees of the Institute in promoting the utilisation of Empire raw materials. The specimens represent typical examples of the principal raw materials investigated at the Imperial Institute and are arranged in the following groups: fibres, silk, paper-making materials, timbers, rubber, oils and oil-seeds, tobacco, tanning materials, essential oils, resins, drugs, and minerals. In addition to the raw materials themselves, specimens are also shown of products obtained from them. Each of the paper-making materials, for example, is accompanied by paper made from it in the Institute's laboratories, and, in some cases, at paper-mills. Similarly in the case of essential oils, drugs, etc., the principal constituents, isolated at the Institute, are exhibited, and, in the case of tanning materials, specimens of leather tanned with them are shown. With regard to minerals, specimens of bricks, tiles, pottery, and cements prepared in tests carried out at the Institute are on view. The collection also includes copies of the principal publications of the Institute, and photographs are shown of the Institute, of its laboratories, and of certain typical exhibits in the Public Galleries.

Silk Section.—A special exhibit indicating the possibilities of silk production in the Empire has been arranged

in the Silk Section (Palace of Industry), the space being kindly provided by the Silk Association of Great Britain and Ireland (Inc.). The exhibit illustrates results of the experimental trials of the Imperial Institute Advisory Committee on Silk Production and of the investigations on silk carried out in the Scientific and Technical Department, and comprises samples of cocoons, reeled silks, thrown silks, yarns and fabrics manufactured by firms represented on the Committee.

Chemistry Section.—In addition to these exhibits, a series of specimens of the alkaloids (and their derivatives) of various species of aconite, prepared by Professor (now Sir Wyndham) Dunstan, F.R.S., and his co-workers at the Imperial Institute, has been arranged (Stand A.41) in the scientific chemical exhibit in the Palace of Industry organised by the Societies representing British Chemical Science.

Cyprus Section.—In connection with the Imperial Institute Silk Committee's enquiry regarding Cyprus silk, exhibits of cocoons, reeled silks, thrown silk, and silk fabrics manufactured by members of the Committee have been furnished to the Cyprus Section.

Nigeria Section.—Samples of Anaphe silk nests from Nigeria, and degummed silk prepared by the Scientific and Technical Department, together with samples of dyed yarns and fabrics manufactured by members of the Imperial Institute Silk Committee, have been supplied to the Nigerian Section.

Specimens of the distillation products of Udi coal have also been supplied for exhibition in the Nigerian Section. The question of the carbonisation of this coal has been investigated at the Imperial Institute, and large-scale trials have been conducted by Messrs. Sutcliffe, Speakman and Co., by whom the present specimens of smokeless fuel, crude tar, partially purified benzol, and briquettes were produced.

British Honduras Section.—At the request of the Colonial Government, a series of nine panelled cabinet doors, polished, made from different British Honduras timbers by a firm represented on the Imperial Institute Advisory Committee on Timbers, together with planks of selected timbers prepared for exhibition purposes, have been sent to the British Honduras Section. The timber was obtained from material under investigation at the Imperial Institute.

British Guiana Section.—Specimens of thirteen woods from British Guiana, which have been recently examined at the Institute as possible paper-making materials, have

been supplied to the British Guiana Section, together with specimens of paper made from them in the Institute's laboratories.

Uganda Section.—Specimens of certain raw materials from Uganda which have been examined from the same point of view have been supplied to the Uganda Section, together with specimens of paper made from them at the Institute.

Ornamental tiles and pottery made from certain Uganda clays in the Institute's ceramic laboratory have also been furnished to the Uganda Section.

General.—The Imperial Institute has received numerous requests for suggestions and advice from the Exhibition Commissioners for various countries taking part in the British Empire Exhibition. In many instances personal visits have been made by the Commissioners to the Public Galleries of the Institute for the purpose of obtaining suggestions for exhibits, and show-cases, photographs, pictures, models, ethnological exhibits, specimens of timbers, vegetable products and minerals have been lent by the Institute for use at Wembley. The following countries have participated in these loans: India, Burma, Australia, New Zealand, Newfoundland, British Honduras, British Guiana, Kenya, Nyasaland, Zanzibar, Gold Coast, Sierra Leone, Nigeria, Sudan, Somaliland, Mauritius, and Cyprus.

Essential Oil from the Gum-Oleo-Resin of Boswellia serrata.—The results of an investigation at the Imperial Institute of the essential oil, resin, and gum from the gum-oleo-resin of *Boswellia serrata*, Roxb., as possible substitutes for oil of turpentine, colophony and gum arabic respectively, have already appeared in this BULLETIN (1915, **13**, 351; 1919, **17**, 159). The chemical composition of the essential oil was also investigated by Puran Singh, late Chemical Adviser to the Government of India, who stated that the major portion of the oil consisted of *d*-*a*-pinene and *β*-pinene (*Indian Forest Records*, 1918, **6**, 321, 323). More recently the oil has been examined by J. L. Simonsen, D.Sc., F.I.C., at the Forest Research Institute, Dehra Dun (*loc: cit.*, 1923, **9**, 289), and this investigation has shown that the statement of Puran Singh is erroneous and that the main constituent of the oil is *d*-*a*-thujene, a terpene which has not been found previously in nature. In addition to *d*-*a*-thujene, small quantities of *a*-pinene and *d*-*a*-phellandrene were detected. In the higher boiling fractions of the oil a very small amount of an unidentified crystalline substance was isolated. The re-

mainder of the oil was considered to contain sesquiterpenes and sesquiterpene alcohols.

A sample of oil which was stated to represent the higher boiling portion of the essential oil from *B. serrata* gum-oleo-resin was received at the Imperial Institute for examination, in 1916, from the Forest Economist to the Government of India. An investigation of this oil was carried out at the time, but the results were not published, as it was hoped that it might have been possible to make a more thorough examination of the entire oil, including the lighter fractions ; in view of the work of Dr. Simonsen, the examination of the lighter portions became unnecessary, and the results of the investigation made in 1916 with the sample in question were given in a paper communicated to the Society of Chemical Industry by O. D. Roberts, F.I.C., of the Scientific and Technical Department (*Journ. Soc. Chem. Indust.*, 1923, 42, 486 T). A summary of the chief results is given below.

The product consisted of a mobile, greenish-yellow oil with a pleasant, characteristic, aromatic odour, and had the following constants :

Specific gravity at $\frac{15^\circ C.}{15^\circ C}$	0·8792
Optical rotation in 100 mm. tube at 22° C.	+ 10° 50′
Acid value	1·2
Ester value	4·9
Ester value, after acetylation	58·8

When the oil was submitted to fractional distillation, it was observed that the rectification had been very imperfectly carried out, for the oil still consisted largely of low boiling terpenes, 50 per cent. distilling below 190° C. under atmospheric pressure. The portion of the oil which boiled above 190° C., which it was estimated formed about 20 per cent. of original unrectified oil, had a specific gravity of 0·9094 at 15°/15° C., and on chemical examination was shown to have the following approximate composition :

	Composition of oil boiling above 190° C. *Per cent.*	Amount in the entire essential oil. *Per cent.*
Aldehydes, chiefly or entirely anisic aldehyde	1·2	0·2
Phenols, unidentified	0·4	0·1
Phenol ethers, chiefly or entirely methylchavicole	23·0	4·6
Alcohols, calculated as terpineol	30·8[1]	6·2[1]
Esters, calculated as terpinyl acetate	3·4	0·7
Residue	41·2[2]	8·2[2]

[1] *This may include some sesquiterpene alcohol, which probably would not be quantitatively acetylated.*
[2] *Viscous liquid containing sesquiterpenes.*

Cultivation of the Tung Oil Tree in the United States of America.—Hitherto the whole of the ten million gallons of tung oil used annually by the paint, varnish and allied industries of the United States of America has been imported from China. With a view to making the United States independent to some extent of foreign supplies, the cultivation of the tung oil tree (*Aleurites Fordii*) has been started in the Southern States. Reference has already been made in this BULLETIN (1921, **19**, 219) to the successful cultivation of the tree by the United States Agricultural Department, and during the last twelve months considerable further progress has been made. Over sixty varnish makers have subscribed sufficient funds to make it possible to plant a large acreage of tung oil trees in Florida (*Sci. Sect. Educ. Bur., Paint Manuf. Assoc., U.S.A., Circ.* No. 195, 1924), and two groves have been selected for the purpose at Gainesville. Osceola Grove, which is 70 acres in extent and is situated on the outskirts of the town, has been ploughed, and planting of the seedlings commenced. These are placed 12½ ft. apart, in rows 30 ft. distant from one another. The other grove, Paradise Grove, has an area of 200 acres, and is situated about three miles from Gainesville. The ground here has now been cleared, and is being made ready for planting. A nursery of six acres has been formed, which contains about 125,000 seedlings a year old and from 12 to 30 in. high. From these seedlings will be selected the most hardy strains of plants for transplanting to the two groves.

An account of the cultivation of the tung oil tree in China and of the uses of the oil will be found in this BULLETIN (1913, **11**, 441), and in view of the experiments on the cultivation of the tree, suggested by the Imperial Institute, which are in progress in India, Ceylon, Malaya, Kenya, Tanganyika and South Africa, it may be of interest to summarise the methods of cultivation recommended in the *Circular* referred to above which experience has shown to be reliable.

The tung oil tree requires an annual rainfall of at least 25 in., and in China has been found to thrive best in districts where a heavier rainfall is experienced. The temperature should not fall below 20° F.

Although the tree will grow on a variety of soils, it prefers a sandy loam well supplied with humus. The soil should be fairly well drained, and in those cases where there is a danger of water standing round the trees after heavy rain, the trees should be grown on ridges about 1 or 2 ft. above the level of the ground. Prior to planting, the ground should be ploughed deeply after all the surface

vegetation has been harrowed under. A second harrowing after ploughing should be given to pulverise the soil.

Young vigorous trees from the nursery are planted at a distance of 12½ ft. from each other, in rows 30 ft. apart. The roots of the plants should be kept moist while being transplanted, and the soil round the planted trees should be well watered until it is thoroughly moist, the holes being filled up with top soil which is then well trampled down. It has been found that the best time for transplanting is when the trees are dormant, namely from the middle of December to the middle of February. No fertiliser should be applied at this period. After planting, the seedlings are cut back to a height of 12 to 14 in.

During the growing season shallow cultivation should be frequently carried out, especially of the strip of ground 3 to 4 ft. wide on each side of the rows of trees. It is advantageous to grow a leguminous cover crop between the lines to enrich the soil. Two applications of a high grade commercial fertiliser should be made during the first year after planting, one in the latter half of February and the other in June. About one pound per tree is applied at each application, in a ring a foot wide, a foot from the tree. This fertilisation may be beneficially supplemented by a light application of nitrate of ammonia in April, and a second in August.

At the end of the first year after transplanting, the tree may be from 4 to 8 ft. high, and in some cases may produce full-sized fruits. It is, however, advisable to remove the fruits during the first year, to prevent them from maturing, and to enable the tree to develop fully. In subsequent years the fruits are allowed to ripen and fall to the ground, where they remain until they are dry, which will generally be by the beginning of December.

"**The Empire Cotton Growing Review.**"—The Empire Cotton Growing Corporation has recently undertaken the publication of a quarterly journal, *The Empire Cotton Growing Review*, the first number of which was issued in January last. The journal is edited by Dr. J. C. Willis, F.R.S., and will deal chiefly with the various aspects of cotton cultivation, including statistics of the industry and particulars of legislative enactments affecting it.

The first number is an excellent production and sets a high standard which, if maintained, will ensure to the journal a future of great usefulness. It contains an introductory article giving an account of the history, constitution and objects of the Empire Cotton Growing Corporation, obituary notices of Mr. J. W. McConnel and Mr.

William Robson (Curator of the Botanic Station, in Montserrat, from 1905 to 1923), an article on the Imperial College of Tropical Agriculture by Sir Francis Watts, K.C.M.G., and another on the Indian Central Cotton Committee by its Secretary, Mr. B. C. Burt, B.Sc., M.B.E. Cotton in Tanganyika Territory is the subject of an interestingly written article by Mr. R. Cecil Wood, the Corporation's Cotton Specialist in the Territory, and a Preliminary Note on a Sterile Dwarf Rogue in Sea Island Cotton is contributed by Mr. L. H. Burd, B.A., the Corporation's Cotton Research Worker in St. Vincent, West Indies. There are also a series of cotton crop statistics compiled by Prof. John A. Todd, B.L., and several pages of notes on current literature.

Irrigation of the Tokar Plain, Sudan.—References have been made in this BULLETIN from time to time (see especially 1904, **2**, 47, and 1920, **18**, 135) to the cultivation of cotton on the Tokar Plain or Baraka Delta. The Tokar Plain is about fifty-six miles S.E. of Suakin, and forms a roughly equilateral triangle with sides about forty-three miles in length. The Plain has been formed by the continued deposition of silt brought down by the river Baraka. The area devoted to cotton varies greatly from year to year, as it is dependent on the extent of the inundations caused by the annual overflow of the river. It was pointed out in this BULLETIN (1920, **18**, 137) that further development in the Tokar region depends on the regulation of the flood by artificial means. A study has now been made of the possibilities of such regulation, and a "Report on Tokar, with Proposals for the more Efficient Utilisation of the Khor Baraka and its Flood Waters" has recently been prepared by Mr. F. W. Cramer Roberts, Inspector of Irrigation, Ministry of Public Works, Egypt (Government Press, Cairo, 1923). It is shown in this Report that so long as the Khor Baraka is uncontrolled, it will naturally follow the line of least resistance and discharge its waters over that tract of country which has the lowest altitude and fewest obstructions. By the continued deposition of silt on this tract its general level will be gradually raised and the waters of the Baraka will then spread out over a new area at a lower level. For this reason only a small portion of the total volume of the Baraka waters is usefully distributed over the Plain, whilst the remainder, following the lowest depressions, is largely ineffective and to a great extent wasted, much of it often flowing into the sea.

Mr. Cramer Roberts's proposals for the prevention

of this waste and the satisfactory irrigation of larger areas are well summarised in the Foreword to his report, contributed by Mr. P. M. Tottenham, Under-Secretary of State, Ministry of Public Works, of which the following is an extract :

" The proposals may be illustrated by likening the Baraka and its plain to a long-handled fan. Mr. Cramer Roberts advocates the encouragement of the freest possible flow from the end of the fan's handle at Shiddin, to the hinge of the fan or point of deflection in Bahr Era, in order that the Khor shall scour out its bed and correspondingly lower the water surface, with the object of bringing it within soil if possible, for he points out that, if there is any interference on that reach, the bed of the Khor will surely silt up and induce the Baraka to abandon its present channel and possibly leave the present plain high and dry.

" The stream having been confined to a well-defined channel for some fifteen kilometres from Shiddin to the hinge of the fan, the construction of masonry works of control at that point is deprecated, because of the instability of the main channel and the heavy silt, the trees, etc., carried by the flood. Instead of that, Mr. Cramer Roberts rightly advocates the construction of a short guiding bank at the hinge of the fan, combined with three permanent banks, each about twenty-five kilometres long, running radially down the vanes of the fan, so as to divide the plain into four sectors of approximately equal area.

" By means of the short guiding bank, which would be built across the openings to all sectors but one, the earlier flushes would be diverted into a high sector specially selected and, when it had been well irrigated, the guiding bank would be cut at the point where it crossed the entrance to the lowest sector, to allow the later flushes to pass into it, and inundate and gradually raise its level.

" It is suggested that the sector chosen for the earlier flushes should be so favoured for three years, when another sector would be irrigated for a similar period, whereas the lowest sector's period would last until it was no longer the lowest, when it would take its turn with the others for irrigation during a term of years.

" By these means, the available supply would be used to the best advantage, owing to the elimination of losses, the annual allotment of land would be facilitated, cultivators in the chosen sector would know what to be prepared for, and lands having been sufficiently irrigated, they could be sown without fear of being again flooded out ; while those in the lowest sector would also be able to get ready

to take advantage of big floods over a long term of years."

It is not considered at all probable that complete control of such a formidable mountain torrent as the Khor Baraka could ever be obtained except at a prohibitive cost, but it is thought that by means of the works proposed, it would be possible to secure such partial control as would lead to a large measure of success in increasing the area available for cotton cultivation and thus enhancing the prosperity of the district.

Chinese White Wax.—The following particulars regarding the collection and utilisation of this wax, which is produced by the larva of an insect known as *Coccus pela*, are given by Sir Alex. Hosie in *Szechwan: Its Products, Industries and Resources*, a notice of which is printed on p. 101 of this BULLETIN.

In the valley of Chien ch'ang, Szechwan, nodules are found in spring on the stems of the large-leaved privet (*Ligustrum lucidum*). These nodules are the dried-up scales of the mother-insect, containing her offspring in the form of a flour-like mass of minute grey creatures. The scales are removed from the privet stems, and are enclosed (twenty or so together) in large leaves of the wood-oil tree (*Aleurites* sp.), which are then suspended by straws in the branches of the ash known as *Fraxinus chinensis*. As each packet is suspended, one or two holes are drilled in the leafy envelope. As the weather gets hotter, the larvæ develop and leave the scales by the apertures caused by their removal from the stems of the privet. The larvæ spend a few days wandering about the branches of the ash and then take up their positions on the bark, where they deposit a white waxy substance to a thickness of about a quarter of an inch. The deposit is completed in August, when the larvæ pupate inside the wax, from which they emerge later as flies, working their way, tail first, through the wax to the outer air.

The wax thus appears to be deposited as a protection to *Coccus pela* in the larval stage, in which it is particularly liable to be destroyed by a species of ladybird.

The wax after removal from the trees is melted in boiling water, and poured into moulds of various sizes and shapes. It is exported to all parts of China, and is put to many different uses. A small amount is commonly added to the oils used in candle-making, and the candles themselves are coated with it. It is largely employed for imparting a gloss to the higher grades of paper, such as visiting cards and notepaper. In damp, clammy weather

a board thinly coated with this wax is drawn along the surface of satin and silk warps in silk-weaving establishments, in order to facilitate the passage of the strands through the heald loops; whilst the strings of the card-figure are dipped for a moment in a mixture of melted white wax and beeswax to assist their separation by the workman who sits aloft on the figure-weaving loom.

Among various other uses the wax is employed as a polish for jade-ware and small articles of furniture (such as dressing-cases and cabinets), whilst it is universally used in Chinese medicine for coating pills and thus preserving the active properties of the drugs of which they are composed.

Mineral Resources of British Somaliland.—Little information has hitherto been available regarding the mineral resources of the Somaliland Protectorate. From time to time minerals have been forwarded to the Imperial Institute for examination, but these for the most part had been collected by the Chief Customs Officer and other officials, or obtained from natives, no systematic survey having been carried out. In the latter part of 1922, however, it was decided to undertake a preliminary mineral survey of the country, and Mr. R. A. Farquharson, M.A. (Oxon.), M.Sc., F.G.S., Petrologist to the Mines Department, Western Australia, was appointed by the Colonial Office as Government Geologist for the purpose. This officer has recently completed his first tour, extending to a little over a year, and has collected a large number of specimens which he is now studying at the Imperial Institute, where the necessary analytical work is being conducted by the staff of the Scientific and Technical Department. A selection of the economic minerals collected by Mr. Farquharson is exhibited in the East African Section of the British Empire Exhibition.

In view of this Mineral Survey, it may be of interest to refer briefly to the Somaliland minerals which have been received from time to time at the Imperial Institute for investigation.

The results of examination of samples of coal and salt from Somaliland have already been given in this BULLETIN (1915, **13**, 189, 190). The coal proved to be of the sub-bituminous type, somewhat similar to Nigerian coal, whilst the salt consisted chiefly of sodium chloride, from which table salt of good quality could be prepared. Summaries of the results obtained in the case of other minerals of economic interest are given below.

In 1912 and 1913 several samples of bituminous earths

and petroliferous sands were examined, and from the descriptions supplied by the collectors it appeared that these might represent surface indications of the presence of petroleum. On the suggestion of the Institute an oil expert was sent out by the Colonial Office, with the result that crude oil was found about twenty-six miles south-east of Berbera. Samples of the oil obtained from a shallow well were examined early in 1914. This product was a heavy black oil, having the following characteristics:

Specific gravity at 15·5° C.	. . . . . .	0·896
Flash point (Abel closed test)	. . . . . .	48° C.
Viscosity at 60° F. (by Redwood Standard Viscometer)	*secs.*	634
Calorific value	. *small cals.*	10,750
Sulphur	. *per cent.*	0·71

Distillation under different conditions yielded widely varying quantities of fractions boiling above 200° C., owing to the readiness with which the higher-boiling fractions "cracked." Under the most suitable conditions, as much as 82 per cent. of kerosene (boiling at 150°–300° C.), and up to 6 per cent. of petrol were obtained, the residue being of an asphaltic character, suitable for use as a paving material. Distillation at 150° C. gave a residue of 94 per cent. of crude oil which, although otherwise suitable, was too viscous to pass the Admiralty specification for fuel oil.

Specimens of argentiferous galena from the Warsangli country were assayed in 1920 and 1922. They were very similar, consisting of high grade lead ore associated with barytes, but carried only about 1½ oz. of silver per ton. No information was given as to the probable quantity of ore available.

In 1901 samples of muscovite mica from the Mirsa Plateau were forwarded, together with a report by an officer of the Public Works Department which indicated that there is an abundance of this mineral in the Protectorate. The samples were all taken at or near the surface, and hence did not represent a marketable product, but some of them showed promise of valuable material at greater depth. It was, therefore, pointed out to the Colonial Office that further exploration of the deposits was desirable, and it was suggested that a competent mineralogist should be sent out to investigate the resources of the country, with special reference to mica. Owing to military operations at the time, this suggestion was not acted upon.

Soapy clay from near Berbera was examined in 1920. It was yellowish-green, sub-translucent, and talc-like in

appearance and to the touch; analysis proved it to be akin to montmorillonite, and it also had some of the characters of bentonite. Recently the material has proved to be an efficient substitute for bauxite in refining mineral oil.

Gypsum in the form of selenite has also been sent to the Institute, whilst samples of titaniferous magnetite, pyrite altering to limonite, and calcareous wad, which have been received, although not in themselves of economic value, suggest the possibility that deposits of iron and manganese ores may eventually be discovered.

Platinum in the Transvaal.—Hitherto the production of metals of the platinum group in the British Empire has been very small, that of platinum itself being negligible, but the accidental discovery of a series of lodes containing this precious metal in the Waterberg district of the Transvaal, about ninety miles north of Pretoria, may, it is hoped, remedy this deficiency. A description of the occurrence is given in "Platinum in the Waterberg District," by Percy A. Wagner and Tudor G. Trevor (*S. African Journ. Indust.*, Dec. 1923; reprinted as *Bulletin* 101, *Industries Bulletin Series*, Pretoria, 1924), from which the following account has been largely compiled.

The Waterberg district, which has for many years attracted the attention of South African miners as being a highly mineralised area, was proclaimed a public goldfield from 1893 to 1905. Later the discovery of tin resulted in the mining of that metal from 1908 to 1913, but notwithstanding systematic prospecting, both during and since that time, which resulted in the finding of a great variety of minerals, the existence of platinum was unsuspected although the main lode forms a prominent surface feature.

The fact that platinum occurs here in lodes is in itself remarkable, for in the past about 99 per cent. of the world's production of the metal has been won from alluvial placer deposits, platinum-bearing lodes being quite rare and of very limited size.

The outcrops now located stretch westwards from the farm Rietfontein, No. 1638, near Naboomspruit station, and have been traced at intervals to the farm Doornkom, No. 1807, about seventeen miles distant. At the eastern end the deposits are readily accessible from the railway by means of a good motor road.

Geologically the district is a volcanic region, the chief rock type being a dense grey or pink felsite, derived from an acid volcanic glass by devitrification, accompanied by

tuffs and agglomerates, and including one thick band of shale, the whole series dipping to the north-west at an average angle of 30°. This series is unconformably overlain to the east by pink Bushveld sandstone (equivalent to the Cave sandstone of the Stormberg series of the Karroo system), and to the west by the later purple Waterberg sandstone and conglomerate. Underneath and intruded into the volcanic series is the red Bushveld granite. The whole area is greatly disturbed, and numerous powerful faults of different ages striking in various directions are intimately associated with the mineralisation of the district. The main platinum lode occupies a fault in the felsite of post-Karroo age, striking in a north-east to south-west direction, which brings Bushveld sandstone on the south side down against the felsite. It is traceable continuously for 2½ miles, and sends off a branch lode, nearly ½ mile long, from which the highest values in platinum have been obtained. It is on these two lodes that the principal work has so far been done, although farther west as many as six parallel lodes have been located.

The main lode is described as a quartz-impregnated fault-breccia, accompanied by quartz stringers in the felsite ; angular fragments of pink felsite with quartz or patches of specularite or hæmatite lie in a matrix of later white quartz, often with drusy cavities, and always showing a radial-fibrous structure. It appears that there were several periods of brecciation and quartz deposition, intimately connected.

The ore is often of very striking appearance, consisting of quartz, hæmatite and other iron oxides, probably in part secondary after pyrites, with pale green sericite mica, and sometimes with a bright green chromiferous chlorite. The platinum is only visible in hand specimens of rich ore by the aid of a lens, which shows it as fine grains ; but occasionally oblique sections of cubes can be observed in microscopic sections. It evidently belongs to an early stage of the mineralisation, being often intergrown with or enclosed by hæmatite, occasionally with quartz and secondary iron oxides. The composition of the native metal has not yet been clearly announced, but it appears that 20 to 40 per cent. of palladium is present with some iridium and possibly also osmium. This association of platinum with acid igneous rocks, though not unknown, is exceedingly unusual, it being generally conceded that platinum is essentially to be sought amongst the ultrabasic rocks, dunite, picrite, pyroxenite, and the like. The intimate association of platinum and specular hæmatite mentioned above is quite unique.

Assays have proved the ore to be extraordinarily rich in platinum metals at some places, and at others barren, and it evidently varies greatly in quality between spots very close together. However, work is proceeding at numerous localities, some of the gold-mining interests having taken up options, and at least six companies are in active operation in the Waterberg district.

This discovery is expected to prove of enormous value, not only to South Africa, whose gold mines are rapidly approaching exhaustion, but also to the whole Empire.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the Bulletin a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.

AGRICULTURE

Foodstuffs

Sugar.—A series of laboratory and field experiments to determine the nature of the beneficial action exerted by molasses as a manure is recorded in *Bulletin* No. 28 (1923), *General Series, Dept. Agric., Mauritius*, entitled "The Application of Molasses as a Fertiliser to Cane Soils in Mauritius." In Mauritius the application of molasses to cane fields in quantities of from 4 to 15 tons per acre is a recognised practice, and in the case of virgin canes the increase in yield may amount to 9 tons of cane per acre. It has been demonstrated that such an increase is too large to be attributed entirely to the plant food contained in the molasses, and some other contributing cause has been sought, which it was thought would probably be biological in nature. Ebbels and Fanque have suggested that the increase is due to stimulation of nitrogen fixation by azotobacter in consequence of the addition of sugar. This view is opposed by de Sornay, and in fact the action of azotobacter is very variable, and is liable to be affected by other activities of the nitrogen cycle of which it forms a part. The present experiments have shown that on ordinarily rich Mauritius soils the addition of molasses does not increase the rate of nitrogen fixation, although it may lead to the evolution of more active strains of azotobacter ; on poor soils, however, stimulation would prob-

ably result. The most marked effect is in relation to nitrification; after the molasses is applied to the soil, nitrification is entirely suspended, and, in addition, nitrates already existing in the soil disappear, the nitrogen apparently reverting to an insoluble form. Partial sterilisation of the soil appears to take place, ordinary soil organisms being greatly reduced in numbers, while other organisms, notably moulds and torulæ, are stimulated. Subsequently nitrification is resumed at an enhanced rate, and probably leads to the accumulation of nitrates just at the time they can best be utilised by the growing plant. Molasses may, in addition, produce the following effects in a greater or less degree. (1) The direct influence of the plant food added in the molasses. (2) Liberation of plant food from unavailable reserves owing to fermentative action. (3) Improvement in the physical conditions of the soil owing to the flocculation of the clay particles by the molasses. It should be noted that if applied to soils in which canes are in full vegetation molasses can do considerable harm, as it causes a complete temporary stoppage of nitrification. The usual practice is to apply molasses to fields bearing or about to bear virgin canes, or bearing ratoon canes. In the case of virgin canes it may be applied in the cane holes some time before planting or in the rows between young growing canes, whilst in that of ratoon canes it may be applied either around the stools or in the interlines.

Bulletin No. 24 (1922), *General Series, Dept. Agric., Mauritius*, entitled, "Détérioration du Sucre Blanc en Magasin à Maurice," deals with the detrimental changes occurring in stored sugar, which are shown to be due to organisms for the action of which moisture is essential. The sugar, instead of remaining dry and granular, becomes moist and lumpy with a diminution in polarisation and an increase in the content of reducing sugars. Alcohols, ethers and other bodies are developed to a certain extent. It is not possible to produce completely sterile sugar on a commercial scale, but deterioration may be avoided by preventing the moisture content of the sugar from rising to the critical degree at which the action of the organisms commences. The margin of safety commonly adopted is expressed by the formula $W/(100 - S) = 0{\cdot}3$, where W is the percentage of moisture and S the percentage of sucrose in the material. The remedy suggested is the provision of suitable stores of solid construction with doors and windows that are proof against the entry of humid air, and with damp-proof flooring.

A thesis prepared by W. P. Alexander, entitled, " The Irrigation of Sugar Cane in Hawaii," and published by the Experiment Station of the Hawaiian Sugar Planters' Association, contains a detailed description of the various systems employed in Hawaii for collecting water on the forest-covered slopes and conveying it to the fertile but dry areas. A full account is given of a study of the methods of applying water to the sugar cane plantations, and such questions as the conservation of soil moisture, prevention of losses of water in irrigation, movement of water in the soil, water requirements of different varieties of cane and the optimum amount to be applied are discussed. Statistics, numerous photographs and a bibliography are included.

Two papers dealing with researches on sereh disease in Java, which produces a dwarfed bushy growth in affected plants, appear in *The International Sugar Journ.* (1924, **26**, 18, 128). The author reviews in detail the work that has been conducted with the object of determining the cause of the disease, from the first attempt by Treub in 1885 to the present-day work of Kühr on the microflora of Java sugar canes. So far no suggestion as to a definite causative organism has met with general acceptance, but most workers are of opinion that the disease is of a parasitic character.

Wheat.—*Bulletin* No. 26, 1923, *Institute of Science and Industry, Australia*, entitled " A Classification and Detailed Description of the more Important Wheats of Australia " is a revision and extension of *Bulletin* No. 18. Eighty-two varieties of wheat are described, including the forty dealt with in the earlier publication. The descriptive notes of each variety contain details of the agricultural and botanical characteristics, the economic possibilities being also mentioned. Data regarding a large number of varieties grown under the widely dissimilar soil and climatic conditions prevailing at Roma in Queensland, Cowra in New South Wales, Booboorowie in South Australia, and Merredin in Western Australia have been collected and included in the new edition.

Rice.—A very thorough study of the production of rice in Malaya is given in *Bulletin* No. 35, 1923, *Dept. Agric. Federated Malay States and Straits Settlements.* Distribution, irrigation, soils, cultivation and harvesting are treated in detail, as well as native and introduced methods of milling and the economics of production.

Varieties, pests and diseases, and manures are also considered. The cultivation of rice, the staple food of the Malays, was in danger, owing to the large profits more easily derived from rubber cultivation; but the work of the Department of Agriculture, which aimed at producing strains of high tillering power and superior grain character, has resulted in the creation of pure strains capable of giving an increased yield of up to 25 per cent. The seed of these strains is being distributed and the result will be a larger supply of pure grain that should secure better prices to the cultivator than the mixed grain, which is looked on unfavourably by the miller.

Circular No. 290, 1923, *United States Dept. Agric.*, "United States Grades for Rough Rice," contains a list of the grades recommended by the Bureau of Agricultural Economics, U.S. Dept. Agric., and effective from August 1, 1923. They are not fixed and established under the U.S. Grain Standards Act, but it is hoped that they will be adopted by all agencies engaged in the handling of rough rice. The classification divides the material into four classes—Long, Short, Round and Mixed—these being again subdivided into grades, the full requirements of which are given.

Circular No. 291, 1923, "United States Grades for Milled Rice," issued by the same Department, is a revision and modification of the previous grading scheme as published in *Circular* No. 133. The revised scheme comprises seven classes and their subdivisions or grades, each of which is described in detail.

Tea.—An account of research work in connection with the life-history of the tea green-fly (*Empoasca flavescens*, Fab.) is given in *The Quarterly Journ., Scientific Dept., Indian Tea Assoc.* (1923, Part IV., p. 109). This fly has long been blamed for the stunting of the flush of the bushes, although it has not yet been proved to be the actual cause. The article records valuable data regarding the insect, and it is hoped eventually to obtain information which will elucidate the connection of the fly with the damage to the bushes.

The same *Journal*, p. 126, contains "Some Observations on Micro-organisms associated with Tea Fermentation." Certain micro-organisms influence the flavour and aroma during fermentation and it is possible to improve these features by the use of pure yeasts. These yeasts are present on the fresh leaf and increase during withering

and fermentation. Improvement of the qualities mentioned has been proved to be associated with increased numbers of yeast cells, while the organisms found on floors, rollers, etc., are usually undesirable.

With the object of establishing a reliable method of obtaining carefully selected trees, of uniform type, in a seed garden, the following methods have been investigated by the Selection Department of the Tea Experiment Station, Bandong, Java: Crown grafting, rectangular patch-budding, upright stem-layering, inarching, veneer-, shield- and cleft-grafting, shield budding, cuttings and various other methods. Of these the first three only are recommended (*Med. Proefstation v. Thee*, No. 85, *Dept. v. Landbouw, Java*, 1923).

OILS AND OILSEEDS

Coconuts.—Experiments were carried out in India in 1913–14 which indicated that a typical bud-rot could be produced on young coconut seedlings by inoculating them with the fungus, *Phytophthora palmivora*. Sharples and Lambourne, however, doubted whether this fungus was capable of producing a similar result on mature palms (see this BULLETIN, 1922, **20**, 359). Further experiments were, therefore, conducted by Sundararaman in India towards the close of 1922 in which mature coconut palms were inoculated with the fungus (*Agric. Journ., India*, 1924, **19**, 84). Two well-grown healthy palms, about fifteen years old and with stems about 12 feet high, were selected for the experiment, and a culture was made from the diseased leaves and leaf-sheaths of a coconut tree suffering from bud-rot. Some of the culture was introduced inside the shoot of the palms, the outer portion being covered with coconut fibre, which was kept wet. The treated shoots were sprayed each day with sterile water. Two control trees were treated in the same way, except that no culture was introduced. On the thirteenth day after the inoculation, characteristic diseased spots were seen on the leaves of the inoculated palms. A week later the shoots of these two trees showed signs of yellowing, and at the end of a further three days the shoots had rotted and could easily be pulled out of the crown. In the course of the next two months, the crowns of both the treated palms were blown over, leaving the trees as bare poles. The controls remained healthy throughout. The experiment, therefore, proves that the fungus, *P. palmivora*, can produce typical bud-rot on mature coconut palms.

Experiments on the inoculation of coconut palms with *P. palmivora* have also been carried out by McRae, the Acting Imperial Mycologist of India (*Memoirs Dept. Agric., India*, 1923, **12**, No. 2, p. 57) which confirm the results of Sundararaman. These experiments were made on coconut palms from 1½ to 8 years old, which were inoculated with cultures obtained from diseased palmyra and coconut trees. The results show definitely that the fungus will lead to the death of coconut palms and further that the disease can be passed from the palmyra to the coconut palm and vice versa. The effect of *P. palmivora* appears to be to start a rot which is then carried on at a greater rate by other organisms.

In the same number of these *Memoirs* is given an account of the occurrence of bud-rot of palms in South India, together with a history of the operations that have been performed to combat the disease.

Cyperus esculentus.—The tubers of *Cyperus esculentus*, a native of Southern Europe and North and South Africa commonly known by the Spanish name of "chufa," are used in the South of Europe as an article of food and, many years ago, were roasted and ground in Germany to serve as a substitute for coffee and cocoa. Tubers grown in the United States of America yielded 28·9 per cent. of a pale yellow or reddish-yellow oil with very little odour or taste (*Journ. Agric. Research*, 1923, **26**, 69, 77). The oil appears to have been used in Italy and Egypt as an edible oil and for the manufacture of soap. It was found to have a specific gravity of 0·9120 at 25/25° C., saponification value of 191·5, and iodine value of 76·5 per cent. The fatty acids consisted chiefly of oleic acid with small amounts of palmitic, stearic and linolic acids.

Other constituents of chufa tubers are sucrose and starch, both of which are present in considerable amounts. The sucrose was isolated in a crystalline state, while a yield of 12 per cent. of a perfectly white starch was obtained. The character of the constituents of these tubers would suggest the possibility of a more extended use than is the case at present.

Oil Palm.—Reference has already been made in this BULLETIN (1922, **20**, 229) to the work that is being carried on at the Agricultural Station at Bingerville, Ivory Coast, in connection with the oil palm. Good results have been obtained by the methods there described on about 40 hectares of natural palm forest. Statistics are published in the *Bulletin des Matières Grasses* (1924, No. 2, 33) of

the monthly yields of fruits from this area for 1923. Although the yields vary, it is seen that one result of the proper management of palm forests is that fruits are produced all the year round, and that there is no interval in production, as is the case with palms in an untended area. The average weight of a palm-head in 1923 was over 11 kilos., while the average yield of fruits was about 60 per cent. of the weight of the heads. The fruits gave a yield of nearly 16 per cent. of oil. The total production of this controlled area was about 93 tons of fruits, and as far as can be judged the yield for 1924 will be higher.

The careful management of the oil palm is not only of importance as regards the natural palm forests, but is recommended to the European settler for small or medium-sized estates of oil palms and also for cases where the palms are used to provide the necessary shade for the growth of other crops, such as cocoa. It is further considered that, at present, small oil mills are likely to give the best results, such mills requiring, as plant, two cookers, one depericarper, one or two hand presses, a vat for clarification and one or two nut-cracking machines. Large oil mills would probably follow when the regular cultivation of the oil palm had been established.

Concurrently with the demonstration of the beneficial effects of the proper management of natural palm forests, work on the selection of the most profitable varieties of oil palm for cultivation has been in progress. As a commencement sixty-one palms were chosen for the quality of their fruits, the characteristics sought being a thick pulp, a shell either thin or of average thickness, and a normal kernel. At the beginning of the present year all but twelve of these palms had been rejected on account of their poor yields of fruits. The work is to be continued, and it is expected that the trees which survive the trial in 1925 will provide seed to be employed for plantation purposes.

English Patents Nos. 206,181, 206,536 and 206,762 by Moseley, Dyke and Lever Brothers, Ltd., deal with processes for the extraction of oil from vegetable fruits and nuts, more particularly from palm fruits. According to these patents, palm fruits are submitted to a preliminary " cooking " to loosen the pericarp. This may be accomplished by placing the fruits in closed vessels and allowing anaerobic auto-fermentation to take place when the temperature of the mass reaches 60° C. By this means, however, an undesirable increase in the acidity of the oil is produced. A better method is to heat the fruits rapidly in an autoclave with steam under pressure. This method has the advantages not only of sterilising the fruits and

avoiding the formation of free fatty acids, but also of causing the kernels to become detached from the shells, whereby the subsequent process of cracking the nuts is facilitated. The pericarp may be removed from the cooked fruits by the use of a ball-mill, but it is preferred to carry out this operation in a specially constructed apparatus. This consists of a cylindrical kettle, 4 ft. in diameter and 4 ft. 6 in. high, having two sets of four fixed radial arms, and three pairs of radial arms rotating on a central shaft. The bottom of the kettle is perforated with slits, 3 in. long and ¼ in. wide, while into the top of the vessel is fitted a pipe through which water may be sprayed on to the material within.

From 12 to 16 cwts. of cooked fruits are transferred to the kettle, together with from 13 to 18 gallons of water, the temperature of the mass being preferably 85° to 90° C. The central shaft is rotated at about 40 revolutions per minute; the fleshy, fibrous pericarp is removed through the attrition of the fruits against one another, and almost immediately begins to fall through the slits in the perforated bottom. This separation is facilitated after the first five minutes by further additions of water, care being taken that the total quantity of water used does not exceed 50 per cent. of the weight of the fruits. The operation takes half an hour from the time the material is introduced into the kettle. By this means the resulting nuts are obtained practically free from fibre. The mass of separated pericarp is treated in a centrifugal machine, having a closed basket, when the oil and water are liberated and drained away, and are subsequently separated from one another by any of the customary methods. The fibrous pericarp waste is left behind in the machine. The nuts are cracked in a machine of the usual type, when it is found that, owing to the preliminary treatment in the autoclave, the kernels come away from the shells practically whole and undamaged. The kernels can be separated from the broken shells by any of the usual methods, but preferably by means of a flotation process in which a suspension of clay in water is employed as the flotation medium.

Spurge Nettle.—The seeds of the spurge nettle (*Jatropha stimulosa*) are considered to be an excellent article of food. They resemble castor seeds in appearance, and are composed of 39 per cent. of husk and 61 per cent. of kernel. The kernels contain 33 per cent. of protein and 50 per cent. of a clear, yellowish, semi-drying liquid oil, somewhat less viscous than castor oil, and with a mild and pleasant

taste. The specific gravity of the oil was found to be 0·9257 at 15·6° C.; saponification value, 186·5; and iodine value, 127·1 per cent. The fatty acids consist of 15 per cent. of saturated and 85 per cent. of unsaturated acids (*Journ. Agric. Research*, 1923, **26**, 259.)

FIBRES

Coir.—The preparation of coir and its spinning and weaving is an important industry in Malabar and Travancore. As little information was available regarding the mechanism of the changes which take place during the soaking of the coconut husks for the separation of the fibre from the pithy matter in which it is embedded, an investigation of the process was undertaken in 1920 by F. Marsden, Ph.D., M.Sc., and an account of the results obtained has been published in *Some Studies in Biochemistry* (see this BULLETIN, page 120).

The ordinary method of retting consists in submerging the husks, immediately after their removal from the freshly gathered coconuts, in pits of water. During the first few days the water becomes brown owing to the colouring matter dissolved from the husks. In the course of the next fortnight the colour disappears, a white growth gradually develops, and the odour of sulphuretted hydrogen is observed. Bubbles of gas are evolved during the next three or four months, and cease to arise after six months. The husks are left in the pit for a few months longer, and are then removed, rinsed in clean water, drained, and beaten with a wooden mallet or a flat stone. The fibres are thus loosened from the pith, and, after drying and the removal of the dry pith by willowing, are roughly carded and sorted into the coarse brush or bristle fibre and the finer spinning fibre.

For the purpose of the investigation samples of the husks and retting water were collected from various centres and forwarded to the Indian Institute of Science at Bangalore. The results of their examination showed that the retting is not dependent on the particular water employed, but is due to bacteria which are invariably present in the coconut husk from whatever locality in the South of India it may be derived. It was also found that the fibres and pithy matter are bound together in the husk by a substance of an insoluble, gum-like character, and that husks from ripe nuts are more rapidly retted than those from unripe nuts.

The variations of colour in the coir produced in the ordinary retting process are due to the presence of soluble

tannins which are readily converted by oxidation into a red, insoluble, phlobaphene-like substance. This causes the reddening of the coir, and it is in order to avoid its formation that it is necessary to transfer the husks to the retting water immediately after the splitting of the coconuts. The production of dull-coloured or "grey" coir when floods occur just after the husks have been placed in the retting pits is due to the reaction of the tannin with the iron compounds carried in the flood-water from lateritic soils.

The rate of retting is reduced by floods owing to the washing away of the bulk of the bacterial growth and the reduction of the temperature of the mass of husks by the cold water; it takes some time for normal retting conditions to become re-established.

For the efficient retting of coconut husks, it therefore appears necessary to select ripe nuts; to place the husks in water as soon as possible after splitting the nuts; to regulate the flow of water so that it is not rapid enough to wash away the established bacterial flora, but is sufficient to remove soluble waste and gaseous products; and also to maintain the temperature by protecting the retting areas from the effects of flood-water, thus incidentally preserving the brightness of colour of the coir.

Cotton

Tanganyika.—An account of the progress of cotton growing in this country has been given in the *Rep. Dept. Afric., Tanganyika Territory, for* 1922. The agricultural officers have devoted their efforts chiefly to giving instruction to the growers and to distributing seed, especially of improved varieties. The quantities of cotton seed distributed to the natives in 1921 and 1922 were 120 and 297 tons respectively, whilst the estimated amount for 1923 was 491 tons. Work on the improvement of cotton production is being carried out by the Cotton Specialist of the Empire Cotton Growing Corporation and his assistant, and reports have been made on twenty-five samples of cotton as ordinarily grown and ten from plant selections by the agricultural officers. The improvement and extension of marketing facilities have received special attention in the direction of the supervision of the ordinary cotton markets and the holding of auction markets in the Morogoro, Rufiji and Lindi Districts. In all the chief cotton districts the growers have been encouraged to clean and grade their cotton, two grades being recognised, viz. (1) clean white cotton, and (2) all other marketable cotton. The teaching of grading methods has been assisted in the

Morogoro District by the provision of prizes by a European firm, and it is considered that the growers will carry out the grading quite efficiently if the prices paid for the higher grade are such as to repay them for the extra work involved.

The quantities of cotton produced in the different districts of Tanganyika during the seasons 1921–22 and 1922–23 are stated below:

District.	1921–22. lb.	1922–23. lb.
Morogoro	1,039,257	848,304
Mwanza	322,080	1,222,025
Rufiji	320,927	269,493
Lindi	798,346	218,032
Bagamoyo	9,389	77,504
Kilwa	92,295	39,796
Dar-es-Salaam	348,694	152,080
Moshi and Lushoto	—	7,929
Pangani	—	4,950
Total	2,930,988	2,840,113

The Department of Agriculture have carried out a great deal of work on the control of cotton pests and diseases. This has included the fumigation of cotton seed which is now effected by means of carbon disulphide instead of hydrocyanic acid gas; the collection and burning of all cotton plants and residues at the end of the season; the inspection of ginneries; the teaching of the methods of destroying pests both in the field and in stored cotton; and the introduction of legislation against pests and diseases and their introduction from abroad. Several insect pests found attacking cotton in the Territory have been studied by the Entomologist and suitable preventive measures recommended.

Union of South Africa.—In this BULLETIN (1923, **21**, 629) a summary was given of a report issued by the Empire Cotton Growing Corporation on the present position and possibilities of cotton growing in South Africa. The cotton now produced in the Union is grown almost entirely without irrigation, the greater part being cultivated in areas with an average rainfall of between 18 and 25 ins. In most of the districts suitable for cotton growing, rainfall is the limiting factor, and even in those with the rainfall mentioned higher yields are obtainable if the land is irrigated once or twice during the dry periods. Many acres of suitable cotton land are already under irrigation, and there are large tracts which it is proposed to irrigate. Under a scheme which has been drawn up for Hartebeestpoort, thousands of acres eminently suited

for cotton are available for cultivation under irrigation. As such land is expensive, it is necessary to devote it to crops which will realise high prices, and long-stapled cotton is therefore recommended.

Trials have been made at the Rustenburg Experiment Station with Sakellaridis and Pima cottons under irrigation, the latter variety being an American-Egyptian cotton, grown especially in the Salt River Valley, Arizona. The results with the Pima cotton were so encouraging that further trials have been carried out, and an account of these is given in *Journ. Dept. Agric., Union of S. Africa* (1923, **7**, 250). An area of 1·76 acres yielded 2,441 lb. of seed-cotton, or 1,386 lb. per acre. The lint was of good strength and colour and 1⅜ in. long. It is anticipated that as the plant has now become acclimatised the yields will be even greater in future. The Pima variety appears to be very well adapted for the Rustenburg District, and should be equally satisfactory in other districts with similar climatic conditions.

Ceylon.—Reference has been made in this BULLETIN (1922, **20**, 106 ; 1923, **21**, 395) to the trials which have been carried out by the Department of Agriculture, Ceylon, in the cultivation of cotton at the Ambalantota Experiment Station and to the interest in cotton growing which they aroused. It is now stated in *Trop. Agric., Ceylon* (1924, **62**, 12), that in order to encourage the industry a scheme has been put into operation which may be summarised as follows. Every cultivator applying for two acres of chena land (land covered with secondary forest or other vegetation which has to be cleared and burned) is given the option of taking a lease of three acres in all, on condition that one acre is planted with cotton, this additional acre being leased at one rupee. By the end of May 1923 applications for land for cotton under this scheme had been received to a total of 1,649 acres. The necessary seed for planting was distributed by the Department, and consisted of a long-stapled American Upland variety obtained from South Africa.

Paraguay.—Cotton growing was at one time an important industry of Paraguay, but was subsequently almost abandoned. During recent years efforts have been made by the Banco Agricola del Paraguay to resuscitate the industry and rapid developments are now taking place. According to a *Report on the Economic and Financial Conditions in Paraguay*, by Mr. Frederick W. Paris, H.M. Consul, Asuncion, which has been issued by the

Department of Overseas Trade, the 1922–3 crop, which it was estimated would be about 1,000 tons, actually amounted to over 3,000 tons of ginned cotton. The 1923–4 crop is expected to be over 6,000 tons. The Government are doing their utmost to encourage the cultivation, and keen competition is being displayed by merchants and exporters. The prices now ruling for cotton afford a sufficient inducement for planters to give preferential attention to the crop, and it is anticipated that in future cotton will be an important article of export. Four ginneries are already at work and others are being installed.

MINERALS

Asbestos

Union of South Africa.—In a paper entitled, "Asbestos in the Union," by A. T. Judge, published in *Journ. Chem. Met. and Mining Soc., S. Africa* (Oct. 1923, p. 84), the Amianthus chrysotile asbestos mine near Barberton, Transvaal (previously mentioned in this BULLETIN, 1921, **19**, 536), is described. The mine is situated on the farm Joubertsdal, where the Jamestown series disappears below the Black Reef series of rocks. Asbestos in the form of a ribbon reef (dipping about 10° N.W.) is met with immediately below a bed of sandstone, which separates green granular serpentine below from less serpentinised olivine rock above. The ribbon reef, 5 to 8 feet thick, is made up of bands of asbestos from ⅛ in. to ¾ in. in breadth, which constitute one-third of the reef content. Below this is the long fibre zone, 8 to 10 ft. thick, in which the intervals between the bands widen, and the bands themselves also widen, so that asbestos fibre from ½ in. to 6 in. long is obtained from them. Below this zone there is a further 6 ft. of rock with thin bands of fibre. The ribbon reef, which has been proved over a distance of nearly half a mile, is remarkably constant, but the long fibre zone is sometimes barren.

The mine is opened up by adits, and attains a depth of 500 ft. The long fibre is hand-sorted in the mine, then taken out, carefully looked over, graded, and bagged in 100-lb. bags as crude fibre. Fibre from the ribbon reef is milled and graded in similar manner to the Canadian product.

Brief mention is also made of crocidolite, amosite, tremolite and asbestic, and the paper concludes with some remarks on the uses of asbestos.

Bauxite

India.—A comprehensive account of the bauxite and aluminous laterite occurrences of India has been given by C. S. Fox in *Mem. Geol. Survey of India* (1923, 49, Pt. 1). Some of the occurrences, such as those of the area surrounding Katni in the Jabalpur district, and of the Balaghat area in the Central Provinces, have been known for many years, and have been described in previous publications of the Survey.

A few of the more important of the numerous later discoveries only can be referred to here.

In the Radhnagri district of Kolhapur State, beds of rich bauxite ore, estimated to contain 2 million tons, have been found. An average sample of this material contained 59·35 per cent. of alumina, 7·0 per cent. of titanium dioxide, and 3·44 per cent. of silica. Water power is available in the vicinity.

The Jummu division of Kashmir State contains bauxite beds, rich in alumina, but somewhat siliceous. One bed is estimated to contain at least one million tons of ore and probably much more. The percentage of alumina in six samples of the ore ranged from 60·65 to 69·90 and that of titanium dioxide from 2·40 to 4·05. The ore could be mined by simple quarrying methods, and transport conditions are favourable for shipping it.

On the Amarkantak Plateau in the Bilaspur district of the Central Provinces are some rich beds of bauxite of unknown extent. Analyses of three samples showed alumina ranging from 52·49 to 58·23 per cent., a rather high titanium dioxide content, and less than 1 per cent. of silica.

In the area around Sapnadand in Sirguja State are found bauxite beds estimated to contain 3 million tons of ore. This has a very low silica content, but contains a somewhat high percentage of titanium dioxide. Analyses of six samples show the presence of from 52·49 to 58·23 per cent. of alumina, and from 6·49 to 10·35 per cent. of titanium dioxide. Over the whole of this region are beds of bauxite ore of good quality, the extent of which cannot be estimated without further exploration.

Many of the more recently discovered occurrences of bauxite in India have only received a superficial examination, but it is likely that some of these will prove to be important.

Greece.—In *L'Echo des Mines et de la Métallurgie* (March 20, 1924, p. 138) is published a communication from M. Georgalas, Director of the Geological Bureau of

Greece, describing a recent discovery of bauxite in the district of Distomo, on the shores of the Bay of Aspra-Spitia, in the Gulf of Corinth. Two samples contained 54·35 and 57·52 per cent. of alumina respectively, while in both cases the percentage of silica was low and titanium dioxide was practically absent.

The bauxite has been found at five different points over a fairly large area. It is considered that these separate occurrences were originally contained in a single bed, since dislocated by tectonic disturbances. The quantity of ore available appears to be considerable, while the situation of the beds is very favourable for the sea transport of the mineral.

Coal

India.—The lignitic coalfields in the Karewa formation (? Upper Siwalik) of the Kashmir Valley are described by C. S. Middlemiss (*Records Geol. Survey, India*, 1923, **55**, Pt. 3, p. 241).

The discovery of a low-grade, rather impure fuel in Kashmir was made in 1922 by the Mineral Survey of Jammu and Kashmir State. It exists in continuous beds from 2½ ft. to about 8 ft. thick. The principal area is that of Handwara, where 8 ft. of available lignite cover 5 square miles, giving 32,000,000 tons of workable coal. The average percentage composition is approximately: moisture, 15; ash, 30; volatile matter, 28; fixed carbon, 27; and the average calorific value is 3,119 calories. The results of experiments seem to show that there may be a considerable future for the lignitic coal of Kashmir, where it has no other competitor except wood. It burns best in English grates, with bars and a good draught. For burning in furnaces, special grates are essential, on account of the large amount of ash.

Canada.—A report by F. H. McLearn on the Peace River Canyon coal area of Eastern British Columbia has appeared (*Summ. Rept.*, 1922, *Geol. Survey, Canada*, Pt. B, pp. 1–46). There is an earlier report on this area by C. F. J. Galloway (*Ann. Rept. Minister of Mines, British Columbia*, 1912, p. 118), but only a few small seams were known at the time it was written, and several thicker seams have been discovered since. The coal occurs in the Gething or Upper Bullhead Mountain formation (Lower Cretaceous), which, besides coal, contains sandstone, slate and clay ironstone, and corresponds to the Kootenay of S.W. Alberta and the Barremian of Europe. The measured thickness of the coal-bearing series is 1,250 ft., in which

are fifty coal seams, thirty-four of which are under 2 ft., fifteen from 2 to 4 ft., and one over 4 ft. in thickness. Ten seams are described in detail in the report. The coals vary in rank from bituminous to semi-bituminous, and are mostly non-coking.

The coal is known only in surface exposures, and in short prospect tunnels. A preliminary estimate of tonnage, in an area of seven square miles, is given as : bituminous coal, 22,680,000 ; semi-bituminous coal, 19,879,000 ; coal of unknown rank, 38,452,000 ; canneloid coal, 3,827,000 ; total, 84,838,000 tons. An area of seven square miles, S.W. of the above, might possibly give a similar tonnage, whilst an area of four square miles to the north might possibly show 21,332,000 tons.

Copper

Canada.—The Lucky Four mining property of Cheam Range, New Westminster mining division, British Columbia, is described by E. C. Cairnes (*Summ. Rept. Geol. Survey, Canada*, 1922, Part A, p. 127). The mine is at an altitude of 6,400 ft. The formation consists of slates, cherts, and limestones of Carboniferous age, intruded by a large batholith of massive granodiorite (probably Miocene). Adjoining the intrusive rock is a belt, 25 ft. or more in width, of mica-schist, next to which is a mineralised belt of altered limestone about 50 ft. in width. Nearest the batholith, the principal mineral of this belt is recrystallised calcite with lustrous cleavage surfaces penetrated by innumerable andradite garnets. Associated with these are pyroxene, zoisite, magnetite, pyrrhotite, and irregularly distributed chalcopyrite. Farther from the batholith are massive beds, one foot or more in thickness, of brownish-yellow grossularite garnet intergrown with diopside. Between the garnet beds are others of green pyroxene with flakes of molybdenite, zoisite and epidote. The principal showing of chalcopyrite occurs in this zone, on the summit of the divide, where it lies between massive beds of grossularite garnet-rock and others composed of epidote, zoisite and pyroxene. The ore veins vary in width from a fraction of an inch to several inches of almost pure chalcopyrite, in which are numerous small crystals of garnet.

Drilling on the northern slope of the divide had proved the continuation of the veins in a regular manner 500 ft. below the summit, and they have been explored on the southern slope to over 1,000 ft. below the summit.

The copper mines of the Granby Consolidated Mining, Smelting and Power Co., Ltd., at Anyox, British Columbia,

are briefly described in the Imperial Institute monograph, *Copper Ores* (1923, p. 57). A paper by T. R. Clapp on mining and smelting at Anyox was read at a recent meeting of the Canadian Institute of Mining and Metallurgy (*Eng. and Min. Journ.-Press*, Dec. 22, 1923, p. 1067). The ore-bodies are found in, and near, the contact of crumpled argillites and an intrusive greenstone of Lower Jurassic age. One class of deposit at Hidden Creek consists of a series of irregular lenses of heavy pyrite, with some copper, at the actual contact ; a second type consists of chalcopyrite and pyrrhotite, occupying the joint-planes and impregnating the rock, near the contact. Innumerable dykes, ranging from ultra-basic to quartz-porphyry, cut the rocks and the ore-bodies. Ore to the amount of 15 million tons has so far been developed in seven ore-bodies, 13 million tons of which have an average copper content of 2·14 per cent. The gold and silver contents vary in value from 12 to 90 cents per ton. Chalcopyrite, the only copper mineral of consequence, is intimately mixed with pyrite and pyrrhotite. Blende and arsenopyrite occur in very small amounts.

The Bonanza ore-body, south of Anyox, is tabular with a low dip to the north. The foot-wall is a greenstone-amphibolite, and the hanging-wall argillite. It contains 300,000 tons of an average grade of ore containing 2·49 per cent. of copper, including dykes, which form 20 per cent. of the mass.

Prospecting is largely carried out with the diamond drill, and a total of about twenty-seven miles of diamond-drill ores have been made. Mining is by shrinkage stoping and by the " glory-hole " (milling) method. Semi-pyritic smelting is practised at Anyox.

United States.—Deposits of native copper in Virginia, Maryland and Pennsylvania are described by Thomas L. Watson (*Econ. Geol.*, 1923, **18**, 732). The region, a mountainous one, lies between the Appalachian Valley on the west and the Piedmont Upland on the east. The ore occurs in altered basalt lava, known as Catoctin schist, which is in two belts, trending in a general N.E.–S.W. direction, and is of pre-Cambrian (Algonkian) age. The principal copper-bearing belt is on the west, and is separated from the eastern belt by intrusive rocks, consisting of granite or quartz monzonites and their metamorphic equivalents, in part younger than the basaltic lavas.

Native copper is the chief ore mineral. Associated with it are usually cuprite, some bornite and chalcopyrite, and, occasionally, a little chalcocite. The copper minerals

occur as disseminations in the more strongly epidotised portion of the basic rock, including quartz veinlets and similar bodies of epidosite, and along crevices and joint planes. Of the non-metallic minerals associated with the copper, epidote, quartz and chlorite are the commonest, and are almost always present. These are followed by serpentine, calcite and pink felspar.

The bulk of the ore is said to be largely confined within 50 or 60 ft. of the surface, but further exploration and development are needed to verify this. Numerous attempts have been made to work these ores in Virginia and Pennsylvania, but so far with only slight success. In Virginia they have been developed by shafts to a depth of 300 ft., and, in a bore-hole, copper was reported at a depth of 600 ft.

Corundum

Union of South Africa.—In a previous note in this BULLETIN (1922, **20**, 378) the Zoutpansberg corundum deposits were mentioned. In *S. Afr. Journ. Indust.* (Jan. 1924, p. 27) experiments are described which show that abrasive wheels, equal if not superior to the best imported products, can be produced quite cheaply within the Union. Experimental wheels were made by F. J. Tromp and A. J. van Tonder, of the Transvaal University College, Pretoria, and comparative abrasive tests were made by the Chief Mechanical Engineer of the South African Railways. It is, however, pointed out that the local consumption of abrasive wheels would be insufficient to support an industry, and an export market would have to be found if their manufacture is to prove a success.

Gold

Canada.—The Salmon River District of the Portland Canal Mining Division of British Columbia has already been briefly described in this BULLETIN (1921, **19**, 106 and 424). The following is taken from the *Annual Report of the Minister of Mines for* 1922, and from an article by Alexander Gray (*Canadian Min. Journ.*, Nov. 2, 1923, p. 860).

During the last four years the Premier mine produced 5,650,000 oz. of silver and 170,000 oz. of gold. It has been proved by later development and stoping that the ore-bodies are contained in tuffs as well as in quartz-porphyries. Diamond-drilling has located extensive ore-bodies at considerable depths below the No. 4 level. The grade of the ore in the bottom level and for 100 ft. below, as proved by drilling, has fallen to 0·32 oz. of gold

and 5 oz. of silver. The present mill has a monthly capacity of 4,000 tons. The new mill under construction will have a daily capacity of 1,000 tons. The B.C. Silver Mines adjoin the Premier. Recently an extension of one of the important ore-bodies of the latter mine was found, and is said to give satisfactory values over a width of 25 ft. The Premier owns 38 per cent. of these mines.

At the Indian mines, north of the Premier, the vein is in a shear-zone in quartz-porphyry intruded by dykes. The vein is of quartz, varying from 10 to 18 ft. wide, mineralised chiefly with pyrite and galena, and showing in places specks of native silver. This property now has a big tonnage of milling ore, of good grade, as well as an appreciable tonnage of shipping grade ore.

The Big Missouri, still farther north, is being developed. Good ore was met with here at a depth of 40 ft. Diamond-drilling has located a large section of ore, averaging over $20 in value per ton.

W. L. Uglow reports on the Windpass Gold Mine, Chu Chua, British Columbia (*Canadian Min. Journ.*, Jan 11, 1924, p. 47). The Windpass vein outcrops at an altitude of 5,300 ft., some five miles N.E. of Chu Chua. The vein strikes E.-W. through the upper micropegmatitic or westerly part of a thick sill, which trends N.-S., and intrudes the Badger Creek cherty quartzites and greenstones, tentatively classed as Palæozoic or pre-Cambrian. The vein appears to pinch out when it passes westerly out of the sill into these beds. It has been developed for a horizontal distance of about 600 ft.. The trend is fairly uniform, and the dip is N. 35°–60°. In its western part the vein is from a few inches to 3 ft. thick, and is filled with quartz, having well-defined slickensided walls. The eastern half is a highly mineralised brecciated zone in the sill showing only minor amounts of quartz. These two types grade into one another. The western extension contains minor amounts of chalcopyrite, pyrrhotite and pyrite scattered through the quartz, associated with grains and blades of native bismuth, free gold and some gold telluride. The eastern mineralised zone is a replacement of the brecciated country rocks by massive magnetite, pyrrhotite and chalcopyrite. Associated with these minerals are free gold, a gold telluride, native bismuth and cobaltite. A layer of solid sulphides occurs in this zone with a thickness of 10 in. to 3 ft., and constitutes high-grade ore. Veinlets of hard, granular magnetite ramify through the wall rock for a foot or two on either side of the vein proper, and carry in general very high gold contents. In the middle part of the outcrop magnetite

predominates, not as the hard granular type, but as a soft, bluish-black steely variety having polarity. This lodestone is full of cavities and fractures coated with limonite, and the walls of the fractures are linked together by chains of lodestone grains, like iron filings at the end of a magnet. Free gold occurs quite commonly in the lodestone, and many samples of it assay upwards of $100 per ton. In the underground workings, which at their deepest are 100 ft. below the outcrop, the lodestone variety of magnetite does not appear.

A review, prepared by Dr. H. C. Cooke, of the Canadian Geological Survey, dealing with recent developments in Northern Quebec, has recently been issued from the office of the High Commissioner for Canada in London as *Canadian Official Mining News Letter*, No. 10. It appears that at least four ore-bodies have been discovered that seem likely to develop into producing mines.

The Chadbourne and Horne properties are within a mile of each other. The country rock is rhyolite, cut by numerous irregularly-shaped masses of fine-grained gabbro, throughout which are scattered bodies of heavy sulphides, mainly pyrrhotite, with pyrite and chalcopyrite. Some of these bodies carry gold worth $7 to $10 per ton, together with 5 per cent. or more of copper in places. Exploration has been greatly retarded by the hard gossan capping, but this difficulty is now overcome, and diamond drilling is being carried on to determine the nature and extent of the deposits at greater depths.

The Lake Fortune property, opened in 1906, has not been worked for the past ten years. Rich specimens of gold and telluride have been discovered recently by trenching, and a shaft is now being sunk to determine the width and value of the vein at greater depth. A full description of the property has been published by Dr. Cooke in *Summ. Rep.*, 1922, *Geol. Surv., Canada*, Part D, p. 69.

Drilling has been carried on at the Stabell property in Dubuisson township, on which there is a quartz vein 2 to 3 ft. wide, heavily mineralised with auriferous chalcopyrite. Results have been very favourable, although exploration has been more or less hampered by a thick deposit of quicksand covering the vein in places.

Australia.—A memoir on the Daylesford Gold-field, Victoria, by H. S. Whitelaw and W. Baragwanath has appeared recently (*Bull.* 42, *Geol. Survey, Victoria*, 1923). The formation consists of Lower Ordovician slates, sandstones and quartzites, which have been sharply folded into

anticlines and synclines, with a general N.N.W. strike and alternating pitch. Although the anticlines are of secondary importance as reef-channels, the profitably auriferous quartz reefs appear to have been found only in the east-dipping beds of the anticlines. Basaltic dykes are fairly numerous in the niches.

Four classes of lodes occur, the order of importance being: (1) verticals; (2) flatmakes; (3) saddle reefs; (4) counter lodes. The verticals are fault reefs, dipping W. 45° to 90°. Flatmakes are massive quartz spurs, more or less horizontal, and with one end connected with a vertical. The counters are quartz veins filling faults which cut diagonally across the strata. Veins of the saddle reef class under 6 in. wide are numerous, but only one of the five larger ones developed has proved to be of economic value.

The principal producing mines have been: (1) North Nuggety Ajax, which, to the end of 1917, produced 48,543 oz. of gold. Payable auriferous quartz has been stoped to a vertical depth of 694 ft. The bottom level is 795 ft. in depth. (2) Ajax Central, which has produced 46,607 oz. of gold. The mine is being sunk to 1,450 ft.; payable quartz goes down to 641 ft. The lowest level is 1,041 ft. in depth. (3) Ajax, which has five parallel lodes. Payable quartz was stoped to a depth of 922 ft. The bottom level is 1,216 ft. in vertical depth. (4) Victoria Cornish, which carries payable auriferous quartz to a depth of 1,000 ft. and has yielded 8,826 oz. of gold. (5) Frenchman's Reef, which from 1906 to 1916 yielded 10,580 oz. of gold. The veins with one exception were payable only in a 60 ft. bed of slate between the Nos. 2 and 6 levels. (6) New Specimen Hill, which from 1912 to 1914 yielded 4,758 oz. of gold. (7) William Tell, which has yielded 3,058 oz. of gold, all of which came from points of intersection of the vein.

Russia.—The Stanovoi gold-belt of Siberia is described by C. W. Purington (*Min. and Met.*, Nov. 1923, p. 555). More than fifty rivers enter the Okotsk Sea, and every one contains gold-bearing gravel. The number of claims, each of three miles' length, staked in the Okotsk district proper, aggregates about 500, of which about thirty have been surveyed for patent up to 1,000 acres each. The total length of stream beds under location exceeds 1,000 miles. It is estimated that over 250,000 oz. of gold had been won from the creeks up to the end of 1922. The output may be estimated roughly at 1 dwt. per sq. ft.

In the Kuktui-Marekan field, immediately surrounding

Okotsk, three principal creeks, each averaging five miles in length, have been worked on the Vogelman property. Pay-gravel, 150 ft. in width, to a depth of 15 ft. has averaged from 1 to 3 dwts. of gold per sq. ft. of bedrock. True bedrock (mainly andesite) was only reached in one of the creeks. On the Pologi Creek, a tributary of the Wet Marekan, 300,000 sq. ft. of clay bottom has averaged 2 dwts. per sq. ft. A terrace, worked in the Varvarinsky mine, is on a small creek, a left tributary of the Kuktui, less than ten miles from the coast. In this terrace payable auriferous layers of sub-angular gravel have been encountered at three different horizons. The deepest, 125 ft. below surface, is 7 ft. thick, and appears to rest on clay. The gold content is said to be 6 dwts. per sq. ft. of bedrock. The width of the lead appears to be under 20 ft., and the direction N.E. At 60 ft. a pay layer is said to average 1·75 dwts. of gold per sq. ft. of bedrock; and at 35 ft., a pay layer, 5 ft. thick, averages 1·20 dwts. per sq. ft. Up to the present the creek and terrace have produced gold to the value of over $500,000. The terrace is possibly of Tertiary age.

The Terkny Amur Co. has worked extensive placer mines on the river Timtom flowing north into the river Aldan, and several other mines have been exploited both on the north and south side of the divide for nearly half a century. The field is but the edge of the Stanovoi gold belt, scattered portions of which, in seventy-five years, produced 30 million oz. of gold.

Iron

China.—In *Bull. Econ. de l'Indo-Chine* of October, 1923 (p. 444), appears an article on "Les Ressources de la Chine du Nord en Minerais de Fer," by M. Raby, Chef du Service des Mines de l'Indo-Chine. This article deals with the iron ore resources of Manchuria and the Chihli and Shantung provinces in Northern China. The deposits contain some rich iron ore, but the larger proportion, while constituting useful ores, are only of moderate grade. Generally, the ores are low in phosphorus and sulphur, and apparently are not titaniferous. The principal deposits are associated with Archæan rocks, and the ore minerals are magnetite and hæmatite.

The Manchurian deposits are the most extensive and are found in four districts. The principal district is Anshan, traversed by the Dairen-Mukden Railway. The ore reserves have been estimated at 400 million tons with an iron content of 31 to 55 per cent. and 2 million tons of richer ore, with an iron content of 48 to 65 per cent. In

1921, this deposit yielded 1,000 tons of the poorer ore and 160,000 tons of the rich ore. The nearest coalfields are at Fushun, 75 miles distant, and at Penchihu, 82 miles away, and the deposits are 185 and 55 miles respectively from the ports of Dairen and Ying-Kow.

The Kung-Chang-Ling deposits are 20 miles from the Antung-Mukden Railway. The ore reserves are estimated at 268 million tons, with an iron content of 29 to 40 per cent., and 2,300,000 tons of rich ore containing 60 to 68 per cent. of iron. A company, capitalised by Japanese interests and the provincial government in the proportions of 60 and 40 per cent. respectively, has been formed to work these deposits. The chief ore mineral is magnetite.

The deposit at Miao-Erh-Kou is 5 miles from a station on the Antung-Mukden Railway, and 25 miles from the Penchihu coalfield. The ore reserves amount to 70 million tons of ore containing 33 to 38 per cent. of iron and 2 million tons with an iron content of 59 to 70 per cent. The deposits are being mined on a scale of about 200 to 300 tons per day, including "fines," which are separated magnetically and afterwards briquetted.

The Kuo-Ti-Shan deposits are relatively small and not of high grade. The ore minerals are magnetite and hæmatite.

In Chihli Province iron ore deposits occur in four districts in the Hsuan-Lung Basin. At Pang-Chia-Pu are deposits estimated to contain 57,800,000 tons with an iron content of 57 to 58 per cent. At Hsin-Yao are iron ore deposits about forty-two miles from Hsuan-Hua station on the Pekin-Kalgan Railway. These are estimated to contain 17,800,000 tons of ore with an iron content of 48 to 59 per cent. Another deposit at Yen-Tung-Shan is about six miles from Hsuan-Hua station. It contains an estimated quantity of 12,900,000 tons of ore with 32 to 58 per cent. of iron occurring in argillaceous schists and sands of pre-Cambrian age. The Lung-Yen Mining Administration has carried out some work on these deposits, but apparently not since 1919.

In the Basin of Luan-Hsien is a group of iron ore deposits of low grade with an iron content from 25 to 40 per cent. The ore reserves are estimated at 31 million tons.

In the Shansi Province are numerous small deposits of iron ore, rather high in phosphorus but suitable for the production of steel by the Martin basic process.

Shantung Province contains one iron ore deposit at Chin-Ling-Chen or Tieh-Shan, near the Tsinan-Tsingtao Railway, and about 120 miles from the port of Tsingtao.

The estimated ore reserves are 13 million tons of hæmatite and magnetite ore with an iron content of 33 to 66 per cent. This deposit was discovered by Germans in 1899 and exploited by them to supply a blast furnace at Kiaochow. The Japanese took over the deposit in 1914 and exported ore from it to Japan.

Lead

Spain.—Alfonso de Alvarado is the author of a memoir on the eastern region of the Sierra Morena (*Boletín del Instituto Geológico de España*, No. 44, 1923, 4 of 3rd series, pp. 299–445). This region includes the important lead mining district of Linares-Carolina.

In Linares, the lodes, with the exception of relatively short zones, occur in granite. The galena contains 76 to 78 per cent. of lead and about 6½ oz. of silver per ton. One variety, called *alcohol de hoja*, carries 85 to 90 per cent. of lead, and is very poor in silver. In this district some of the lead-bearing veins do not appear to be productive below 1,000 or 1,300 ft. in vertical depth, but the author of the memoir points out that in the south-western portion of the Mimbre y San Miguel mine, now under water, galena was followed to a depth of 1,875 ft.

La Carolina has been developed considerably since P. de Mesa's memoir on this district was published in the *Revista Minera de Madrid* in 1889–90, and, although it forms one metallogenetic province with Linares, there are differences in the two localities as regards the filling and structure of the veins and the nature of the country rock. Some of the veins in La Carolina are found in Cambrian slates, others in granite or in granite passing into slates, and others between Silurian quartzites and slates.

Los Guindos vein of the Virgen de Araceli group is in Silurian quartzites and slates near their contact with granite, from which it is separated by slates metamorphosed by irregular masses of quartzose porphyries. This remarkable lode strikes W. 15° N., dips from 70° (in the soft slates) to 80°–85° (in the quartzites), and is on an average 5 ft. in thickness.

In Level 13, 1,575 ft. in depth, the vein is about 6½ ft. in width and nearly vertical, the filling consisting of fragments of quartzite, with nodules and stringers of galena, quartz, some dolomite and a few crystals of barytes. The length of the rich zone or shoot in quartzite is about 984 ft. On either side are laminated slates in which the mineralisation is less. In Gallery 14 (1,673 ft.), the rich zone is in quartzite and 1,017 ft. in length, and consists of alternating

bands of galena, quartz and quartzite. Blende is absent, and pyrite, calcite and dolomite are rare. The thickness of the lode varies from 7 to 8 ft., and the band of galena in the lode is from 1 to 2½ ft. in width.

The Mirador lode of El Centenillo group is nearly vertical, strikes W. 25° S., almost exactly parallel to the Guadalquivir fault, in alternating beds of quartzite and slate (Silurian). The lode is rather a bundle of parallel fractures than a single one. The width is from 23 to 50 ft. (the latter in the central zone). In the soft zones the filling is formed of fragments of slates, clays and nodules of galena. In the quartzites a thick band of galena lies between bands of quartz and fragments of quartzite. Banded structure is characteristic of veins in the quartzite. Crystallised gangues are very scarce in the lower levels. At the surface the rich zone is about 3,000 ft. in length, while in the bottom levels it is 4,264 ft. in length, with no indication of the wedging out of the lode or of the disappearance of the galena, although the mineralisation is not so strong as in the upper levels. The total depth of the mine is 1,522 ft.

The Ojo Vecina mine belongs to the same system of fractures, but the lode is in granite, and the rich columns or shoots go down to a vertical depth of 2,300 ft. For the first 328 ft. the lode was sterile, and was only feebly metalliferous from 328 to 500 ft. From 500 ft. to 1,263 ft. a rich column of galena was won having an average width of about 5 in. for the whole length of the concession. From 1,263 to 1,705 ft. there was a relatively poor zone. From 1,705 to 2,400 ft. another rich zone was met with with very regular mineralisation, the galena averaging 10 in. in width for the whole length of the concession. It should be pointed out that the bottom level is no less than 3,050 ft. vertical below the mouth of shaft No. 1 of El Guindo. In this, the 21st level, there is no indication of the wedging out of the fracture, and the walls are well defined.

The absence of certain minerals in the filling of the veins of Linares-Carolina, such as magnetite, garnets, pyroxenes, tourmaline, etc., indicate that the contents were not deposited at high temperatures. The temperature of the mineralising waters probably ranged from 175° to 300° C. and that of the walls of the veins from 50° to 125° C.

L. de Launay (*Gîtes Minéraux et Métallifères*, 1913, **3**, 73) deduced that the exploitable depth of the Linares-Carolina lodes was probably limited to from 1,000 to 1,300 ft. of vertical depth. Alfonso de Alvarado has

shown that actual development in several mines has already largely exceeded these figures, and there seems reason to believe that greater depths still will be attained in La Carolina.

Petroleum

Canada.—References to the Norman oil area of the North-West Territories, Canada, have appeared from time to time in this BULLETIN (1920, **18**, 458; 1921, **19**, 103 and 420; 1922, **20**, 257). The geology of the Norman oil-fields and a reconnaissance of a part of the Liard River area are described by G. S. Hume (*Summ. Rept.*, 1922, *Geol. Survey Canada*, Pt. B, p. 47).

After the initial success of No. 1 well, on the east bank of the Mackenzie, 53 miles north of Norman, the Imperial Oil Co. began drilling three other wells—the Bluefish Creek well, 8 miles down the Mackenzie from Norman; Bear Island well, 2 miles from No. 1 well; and "C" Camp well, a little farther up on the west bank. In none of these wells has any oil been obtained. "C" Camp well is the deepest (1,704 ft.), but it is uncertain whether it has reached the horizon from which the last supply of oil was obtained in No. 1 well. During 1921, the Mackenzie River Oil Co. drilled to a depth of 1,510 ft., 8 miles south of No. 1 well and on the same bank of the river. Gas was obtained in this well, but no attempt was made to complete the drilling.

As the production of oil from No. 1 well had almost ceased, the hole was deepened to 951 ft. in 1922, and another flow of oil of 60 to 70 barrels a day was obtained. This demonstrates that oil is present in quantity, and gives hopes that many such wells may be found.

The following is a summary of the geology of the region. The age of the mountain-building in both Liard and Mackenzie areas is definitely post-Cretaceous. The rocks of the Norman oil area range in age from Cambrian to Eocene. The potential oil area is greater on the west side of the Mackenzie than on the east side.

The mountains are anticlinal in origin. No. 1 well is on the flank of the major anticline, which forms the Norman range of mountains. The present oil production of No. 1 well is probably from a sandstone, 50 to 75 ft. thick, in the Fort Creek formation underlying the Bosworth formation (Upper Devonian). The sedimentation most favourable for oil accumulation occurs in the Bosworth formation of alternating sandstones and shales, and the portion on the east side of Mackenzie River provides most of the oil

seepages. On the west of the river, the formation is overlain by Cretaceous sandstones and shales, the latter of which are suitable as a cover for an oil-field.

Potash

Spain.—The potash salts of Catalonia, Spain, are described in the Imperial Institute Monograph on *Potash* (1922, pp. 15–20) mainly based on a memoir by C. Rubio and A. Marín, published in 1914 (*Bol. Inst. Geol. de España*, **19**, 351). Marín has now contributed further information on this subject ("Investigaciones en la Cuenca Potásica de Cataluña," *Bol. Inst. Geol. de España*, No. 44, 1923, **4**, 3rd series, pp. 3–77). A geological map, on a scale of 1 : 150,000, shows the Oligocene basin containing the potash salts, the boundary of the zone reserved by the Government, the anticlinal axes, the borings put down or projected by the Government, as well as the position of private borings. There are several geological sections, showing the actual occurrence of the potash salts as proved by the borings, and a number of interesting views, etc. In the same volume are published laboratory researches on, and analyses of, the potash salts by L. Meneñdez y Paget, and data with regard to the borings by Agustín de Larragán.

The basin containing the potash salts is 26 miles long and about 9½ miles wide. In the basin 23 borings have already been put down, 18 of which penetrated the potash deposits. The zone actually proved by borings is about 9½ miles in length and about 3 miles in width. The depth of the potash met with in this zone varies between 656 ft. and 2,624 ft.; or, say, an average of from 1,640 to 1,968 ft., or about the same depth as the potash mines of Germany and Alsace. Taking the minimum thickness of potash as 6½ ft. (or about half that actually proved by the borings), and taking 2 as the density of the potash salts, there are actually explored 268 million tons of potash (K_2O) at exploitable depths. This represents 2,000 million tons of potash salts as they come out of the mine, of which it may be reckoned that 400 million tons are sylvite and the rest carnallite.

The estimate of the amount of available potash in the Catalonian beds is 32 million tons less than that given for the two Alsatian beds (Imperial Institute Monograph on *Potash*, p. 11), but it must be remembered that the estimate of the former deposits is a conservative one, and is based only on that portion of the basin actually proved by borings.

Silver

Canada.—The Keeley Silver mine, South Lorrain, Ontario, and the deep-seated oxidation and secondary enrichment therein are described by J. Mackintosh Bell (*Econ. Geol.*, 1923, **18**, 684). The Keeley mine (Imperial Institute Monograph, *Cobalt Ores*, 1924, p. 27) is 16 miles S.E. of Cobalt, of which it forms a geological outlier, the formation being very similar to that of the Cobalt district (Imperial Institute Monograph, *Silver Ores*, 1921, p. 44). The Keewatin (pre-Cambrian) series in South Lorrain is represented by a greenstone in which lamprophyre dykes ramify in all directions.

Wood's vein, the principal lode of the district, strikes N.–S., and is traceable for one mile. The Keeley veins resemble in most particulars those of Cobalt. The vertical range from which ore extends from the contact is greater in the Keeley veins than in the case of Cobalt. Thus rich ore occurs in Wood's vein to a vertical depth of 480 ft. (where it is wholly in dolerite) or a length along the dip of not less than 550 ft. and possibly more. The metallic minerals show the same variety as at Cobalt, but galena and blende are rarer, and the quantity of iron-bearing sulphide is much higher than at Cobalt. At the Keeley mine there has been great alteration by meteoric waters, especially in the case of Wood's vein. Where completely oxidised (*i.e.* in the "ferric" state), there is little silver in the vein, but where partially oxidised (*i.e.* in the "ferrous" state), the amount of silver present is considerable. The silver in the "ferrous" ore occurs in the wire form as argentite, in spongy accumulations of tiny scaly crystals, resembling miniature stalactites, and as thin plates. One sample of the "ferrous" ore from the 420-foot level of Wood's mine gave 3008·5 oz. of silver and 0·88 oz. of gold per ton of 2,000 lb., while a sample of "ferric" vein material, a few feet away, gave only 3 oz. of silver per ton. The 480-foot level of the same mine has more smaltite than the levels above. No. 26 vein dips vertically and joins Wood's and No. 28 upward in the respective dips near the 420-foot level. The vein in its length of 80 ft., excepting in the few places where it is highly "ferric" consists of exceedingly rich ore, at one point being nearly 5 ft. wide and containing nearly 7,000 oz. of silver per ton. At the widest point more than half of the vein consists of normal silver-bearing smaltite with a little calcite. In the remainder, oxidation has begun, for cobalt bloom and a little iron rust are seen to coat the silver in the cellular spaces.

The High Commissioner for Canada in London has recently issued a brief statement prepared by W. E. Cockfield, of the Canadian Geological Survey, with regard to Mayo and the newly discovered silver region of Beaver River District, Yukon Territory.

High-grade deposits of silver-lead ores were mined in the Mayo district as early as 1914. The discovery of the Keno Hill ores in 1919 led to the entry of two large companies into the field, which have since been actively engaged in mining. The Keno Hill deposits have already been described in this BULLETIN (1921, **19**, 425; 1922, **20**, 391 and 548). Production commenced in the winter of 1920–21, and the total ore shipped up to March 1924 amounted to 13,315 tons having a value of $1,746,527 in silver and $677,923 in lead.

The Beaver River area lies 50 miles to the north of Keno Hill. Some silver-lead deposits were discovered here in 1922, but the ore deposits proved to be low in grade and many of the claims were abandoned. The new deposits lie 16 miles to the east of the former discovery. The stampede to the district, which occurred recently, is reported to have taken place owing to the discovery of high-grade ores carrying 1,100 oz. of silver per ton.

Silver-lead ores have been discovered at many points between the two districts, and as much of the area remains unprospected it is probable that further discoveries will be made from time to time.

Australia.—The silver-lead lodes at Mount Isa, Cloncurry District, Queensland, are described by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, Nov. 1923, p. 412).

The field, discovered in March 1923, is 66 miles W.S.W. of Cloncurry. The area so far explored is five miles in length and one mile in width. The formation consists of laminated clay-shales and slates, sandstones, quartzites, mudstones, cherts and jasperoid quartzites and slates, belonging to the Cloncurry series (Silurian or possibly pre-Cambrian). The silver-lead ores are inter-bedded in the sedimentaries, which strike N.–S. At least five distinct parallel ore-channels are traceable through the field. The central and most contorted area appears to carry the most ore. The major portion of the lode outcrops is very dark in colour, due to a thin surface incrustation of manganese and a little iron oxide. A very notable feature is the occurrence of prominent, nearly continuous outcrops of pale-blue chert within the lode channels. The hard chert and jasperoid outcrops are excellent indicators of the near presence of lead seams. The ore in the main channels

usually consists of narrow bands alternating with bands of country rock. Individual seams of ore are remarkably regular in width over very considerable lengths already proved. A little copper is found here and there in the lead-ore, but there seems to be an entire absence of zinc. An average analysis of the whole of the ore actually sold from Mount Isa district up to Sept. 8, 1923, gave the following percentages: lead, 64; alumina, 5·4; ferrous oxide, 3·75; silica, 4·9; sulphur, 1·85; and silver, 55 oz. per ton of ore. Ore carrying over 40 per cent. of lead and 30 oz. of silver per ton may be considered payable under present conditions.

The bulk of the ore so far won has been carbonate. Some of the seams consist of earthy white amorphous carbonate, others of cerussite, with some anglesite and pyromorphite. Galena, which occurs at the surface occasionally, is in extremely fine-grained granular aggregates. Usually the galena tarnishes very rapidly on exposure to the atmosphere, and it is consistently richer in silver than the carbonate ore.

With but very few exceptions, the whole of the claims and leases seen by Saint-Smith were producing ore of a sufficiently high grade to be payable, notwithstanding the present heavy charges for transport, smelting, etc., and he believes that this discovery will soon prove to be perhaps the most important find of metal made in the Commonwealth during the past decade.

The Nightflower silver-lead lodes, Chillagoe District, Queensland, are described by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, Oct. 1923, p. 367). The area is about 40 miles W.S.W. of Mt. Mulligan, and between the Big Watson River and Elizabeth Creek. Three leases along the line of the lode have been acquired by the State, and will be worked by the Chillagoe State Smelters. The formation consists of coarse- and fine-grained quartz-porphyry, intruded by felsite dykes, and sedimentary rocks consisting of sandstone or quartzite, shale or slate. The lode is found in the very fine-grained quartz-porphyry, as well as in quartzite, the latter occurring in patches, and the former extending for a distance of at least three miles. The silver-lead lode strikes a little east of north, dips W. at a high angle, and is traceable for a length of 7,000 ft. The galena is medium to coarse in grain and carries from 1¼ to 1½ oz. of silver per ton for each 1 per cent. of lead present. Blende is scarce. The oxidised portions of the lode contain both carbonates and oxides of lead and occasionally pyromorphite. Chalcopyrite and pyrite are

found in places, and antimony occurs both as sulphide and oxide.

A sample of 40 tons of ore raised from the Nightflower lease assayed 66·2 oz. of silver per ton, and gave the following percentages: lead, 43·0; insoluble, 34·2; ferrous oxide, 4·3; zinc oxide, 7·1; sulphur, 12·1. Accompanying the galena bands, stibnite occurs as fine needles through the hard, dark, siliceous lode formation. This antimony-bearing material yielded 3·4 to 5·7 oz. of silver per ton. The Nightflower appears to be the premier lease along the line of lode.

In many respects the lode resembles, both in occurrence and in the nature of the ore, those seen at the famous Yerranderic Silver Field, New South Wales (see Imperial Institute Monograph, *Silver Ores*, 1921, p. 56; *Bull.* 2, *Geol. Survey, New South Wales*, 1923, p. 28).

Sodium Compounds

Union of South Africa.—Further information on the Pretoria salt-pan (previously referred to in this BULLETIN, 1923, **21**, 546) has been given by Dr. P. A. Wagner in the *S. Afr. Journ. Indust.* (Jan. 1924, p. 19). As a result of considerable modification of the treatment plant, both salt and soda are now being produced on a large scale. The process, which was evolved by Mr. R. H. Blumenberg, is as follows: the liquor pumped from the bore-holes, which contains about 8·5 per cent. of sodium carbonate ($Na_2 CO_3$) and 15–16 per cent. of sodium chloride (NaCl), is cooled in large refrigerating tanks to 30° F., when 60 per cent. of the sodium carbonate separates as decahydrate. This is collected and steam-heated until it dissolves in its own water of crystallisation, and is then boiled under reduced pressure to convert it into the monohydrate, which, after being almost completely freed from sodium chloride by means of jets of steam, is calcined and bagged in the anhydrous condition. The product contains 97–98 per cent. of sodium carbonate (Na_2CO_3) and 1·2 per cent. of sodium chloride.

The brine from the refrigerators after reaching the atmospheric temperature is filtered and then evaporated in a triple-effect evaporator, where it deposits 60 per cent. of its sodium chloride. This salt, after centrifugal treatment to remove surplus liquor, is bagged and placed in a drying shed to enable the moisture to evaporate. The product contains 99 per cent. of sodium chloride and 1 per cent. of sodium carbonate, and is free from sodium sulphate. It is intended in future to recrystallise a por-

tion of this salt and to produce a refined salt containing only 0·1 per cent. of carbonate. It is also intended to erect plant to treat the residual liquor from the salt plant in order to recover the whole of the salt and soda contained in the original liquor. The present output is about 3 tons of common salt and twice that amount of anhydrous sodium carbonate per day, but it is anticipated that the maximum output of 8 tons of soda and 12 tons of salt will ultimately be reached. Two of the original boreholes continue to yield as much liquor as ever after five years of almost continuous pumping.

Tin

Australia.—The Sardine Tin mine of Kangaroo Hills Mineral Field, Queensland, has been described in this BULLETIN (1922, **20**, 550). Later information on this property is contained in a report by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, June 1923, p. 202), who believes in the probability of the ore on the Sardine lode persisting in depth, and in the possibility of still other ore lenses being discovered. Down to June 5, 1923, 3,096 tons of ore yielded about 700 tons of concentrate (black tin). Other mines in the district reported on include the Canary mine, which has a fissure lode the ore shoots of which are likely to persist to great depths. The ore shoots already discovered occur as elongated pipes, averaging about 15 ft. in length with a steep northerly pitch. Payable ore-bodies will probably be met with in the large cross lode to the north of the shaft. In the Jugular mine, the country rock is a decomposing serpentine slate, seamed with calcite veinlets.

The Black King tin mine, Herberton Mineral Field, is described by L. C. Ball (*Queensland Govt. Min. Journ.*, Oct. 1923, 371). The country rock is a coarse-grained granite. The quartz occurs as irregular masses shading outwards into silicified and chloritised granite. The maximum horizontal length of the separate shoots formerly worked nowhere reached 20 ft., and the width only amounted to a few feet. The stanniferous crystalline quartz masses are found mostly in "black rock" (altered silicified granite) and quite frequently in the vicinity of unaltered granite. Associated with the tinstone are pyrite, wolframite, fluorspar and tourmaline, the last two minerals being found in the upper and lower levels respectively.

Tungsten

India.—The tungsten and tin deposits of Tavoy, Burma, were described in the Imperial Institute Monograph, *Tin Ores* (1920, 23). A memoir on the geology and ore deposits of the Tavoy District by J. Coggin Brown and A. M. Heron has recently appeared (*Mem. Geol. Survey, India*, 1923, **44**, Part 2) from which the following notes are taken.

Molybdenite appears to have been the first ore mineral to be deposited, as it is often enclosed in wolframite or intergrown with mica at the edges of the veins. It was followed by wolframite, cassiterite, bismuth, bismuthinite, and then by the majority of the sulphides, such as pyrite, chalcopyrite, arsenopyrite, pyrrhotite, galena and blende. Fluorspar was one of the latest minerals to be formed as it is usually in crystals coating other minerals. Of special interest is the Pagaye mine of the Rangoon Mining Co. Here pegmatites occur in which wolframite exists in comparatively large quantities, and has been profitably extracted. The associated minerals are microcline-felspar, mica, green fluorspar, scheelite and cassiterite, together with pyrite, chalcopyrite and covellite. From 1910 to 1918 the production of this mine was 1,517 tons of concentrate. The Hermyingyi mine from 1910 to 1918 produced 4,188 tons of concentrate, the average composition of which was 46 per cent. of tungsten trioxide, and 24 per cent. of tin. About sixty veins have been worked, occurring in groups having a general N. and S. trend, and a steep easterly dip. The veins carry wolframite and cassiterite to the lowest point yet reached, 400 ft. in granite below the contact with the sediments overlying it.

NOTICES OF RECENT LITERATURE

SZECHWAN: ITS PRODUCTS, INDUSTRIES AND RESOURCES. By Sir Alexander Hosie, M.A., LL.B., F.R.G.S. Pp. 185, 8vo, 9¼ × 6¼. (Shanghai: Kelly and Walsh, Ltd., 1922.)

As the author states in his Preface, this work is "not a story of travel or adventure," but "a book of reference for one of China's largest and richest provinces from a commercial and industrial point of view." It furnishes a most readable and informative account of the physical features, natural resources, products and industries of this important province, and will repay perusal by all who

are in any way interested in Chinese commerce or Chinese civilisation in general. The work is divided into several sections, the most important of which, dealing respectively with Agricultural and Horticultural Products, Animal Products, and Minerals and Mineral Products, give not only particulars of the materials in question and their uses, but also descriptions of the principal industrial processes used in their exploitation. Thus, to give one example, a detailed account is furnished of the local methods employed in rearing silkworms and in reeling, spinning and weaving the silk; and in connection with this and other industries the author makes useful suggestions as to improvements which might be introduced.

The utility and interest of the information given in the book are considerably enhanced by a plentiful use of botanical and zoological names as well as vernacular forms; and some useful statistics are supplied, although it is evident that in regard to many Szechwan products reliable figures are difficult to obtain. The author makes clear the great importance, actual and potential, of this large province (the population of which he estimates at no less than 45,000,000), and shows that if it could be served with railways and further assisted by the surmounting of navigation difficulties on the Upper Yangtsze, it would play a larger part in Eastern commerce than has so far been possible.

The volume is excellently printed, and contains a copious index as well as two useful maps. It is a valuable compendium of information not easily (if at all) obtainable elsewhere. In connection with any future issue, it may however be suggested that a few illustrations would be welcome, and that attention might be paid to certain details which seem to need revision (*e.g.* on page 59 the author assumes that out of 40,000,000 people only 16,000,000 are adults, though by European analogy the number should be twice as large). It should also be possible to avoid the repetitions which occur in the present edition, apparently owing to the method in which the book has been compiled.

SUB-TROPICAL AGRICULTURE IN SOUTH AFRICA (WITH SPECIAL REFERENCE TO RHODESIA). By H. G. Mundy, Dip. Agric., F.L.S., Chief Government Agriculturist, Department of Agriculture, Southern Rhodesia. Pp. viii + 328, $6\frac{1}{4} \times 9\frac{1}{4}$. (Rhodesia: Argus Printing and Publishing Co., Ltd., 1923.)

This book has been prepared with a view to providing information relating to agriculture likely to be of assist-

ance to new-comers and established farmers in South Africa, as well as to students in agricultural schools. The author has been nearly twenty years in South Africa, and has, therefore, a first-hand knowledge of the kind of information required, as well as of the local conditions. It is his opinion that mixed farming is the system likely to prove most successful in South Africa, and the book gives an account of the various crops and cultural operations which this system involves. The book is divided into two parts ; the first part treats of farm management, whilst the second is devoted to crops. Following a description of the various kinds of soil met with in South Africa and an account of tillage operations and crop rotation, the need for manures is emphasised, and the relative values of farm-yard manure, green manure, and artificial fertilisers are discussed ; soil erosion and its prevention are also dealt with. Descriptions are then given of mixed farming and dry-farming as applied to conditions in Rhodesia. The evil results of veld burning are described, and the treatment of hay crops and ensilage receives attention. An interesting chapter on acquiring land for farming contains some valuable hints to beginners and intending purchasers of land in South Africa. Instructions for measuring land, and some useful tables relating to the weight of seeds, quantities required for sowing, and distance for planting, with other data of a similar nature, are supplied.

In the part treating of crops, the first place is given to maize, as being the crop of most importance in South African agriculture ; other major crops dealt with are wheat, oats and barley, potatoes, and beans. The miscellaneous crops described include groundnuts, sunflower seed, linseed and niger seed ; rice and buckwheat ; onions ; the kudzu vine (*Pueraria Thunbergiana*) a recent introduction to South Africa from Japan and a most promising forage crop; dhal, or pigeon pea, and sunn hemp; mangels, sugar-beet, turnips and swedes ; kaffir corn (sorghum) and coarse fodders ; annual grasses and millets ; cotton ; lucerne, beggar weed (*Desmodium tortuosum*), clovers, and pasture grasses. The concluding chapter is devoted to orange-growing, which, during recent years, has assumed commercial importance in South Africa, as, owing to the season of ripening, the crop has a monopoly of the European market from June to September. Tobacco cultivation and curing, and sugar-cane growing for sugar manufacture, are not dealt with in this book, it being considered desirable to devote a special book to the former subject, whilst the sugar-cane is not considered a suitable

crop for the particular locality this book is intended to serve.

It will be seen that under the system of mixed farming which the author advocates, a wide range of crops is available for cultivation, and the adoption of this system should tend to ensure success in South Africa in regions where the rainfall is uncertain and a large proportion of the soil has no great natural fertility. To those for whom it has been specially prepared, the book should prove of great service as it indicates the best agricultural methods, and the crops that are available for the varied conditions of soil and climate which obtain in South Africa.

THE PRODUCTION OF FIELD CROPS: A Textbook of Agronomy, by T. B. Hutcheson, M.S., M.S.A., and T. R. Wolfe, M.S., Ph.D. Pp. xv + 499, 8vo, 9 × 6. (New York and London: McGraw Hill Book Company, Inc., 1924.) Price 17*s.* 6*d.*

In preparing this book the authors had in view the needs of a standard course in field crops. An outline of such a course had been prepared by a Committee of the American Society of Agronomy, and this has been followed as far as practicable. The book is divided into forty-five chapters, of which the first twenty-eight are devoted to the fundamentals of agriculture and the common practices in the production of crops. The remaining chapters, which are devoted to the crops themselves, are not intended to be exhaustive, as it is anticipated that supplementary information would be given by the teacher, who would supply the necessary local data. Corn (maize) takes the first place amongst the grain crops described, and is followed by wheat, oats, barley, rye, buckwheat and sorghums; then follow chapters on cotton, tobacco, potatoes, sweet potatoes, peanuts, grasses, clovers, alfalfa, soy beans and miscellaneous crops. As the book is primarily intended for use in the United States, the crops and methods of cultivation are those common to that country. The chapters dealing with fundamentals and such practices as tillage, manuring, seed selection, harvesting and storing of grain, silage and crop rotation are, however, of wider application, and should prove useful to the student of agriculture in any country. The book is well printed and fully illustrated, and is supplied with a number of outline maps showing the distribution and importance of the various crops in the United States. Appended is a lengthy bibliography, chiefly of Bulletins of the United States Agricultural Experiment Stations; and a good index is provided.

COTTON IN NORTH BRAZIL: being the Report of a journey through the States of Ceará, Maranhão and Pará, together with a Synopsis of the whole of Brazil's Cotton Potentialities. By Arno S. Pearse, General Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations. With Preface by His Excellency Dr. Miguel Calmon, Minister of Agriculture, Commerce and Industry, Rio de Janeiro. Pp. 130, 8vo. (Manchester: International Federation of Master Cotton Spinners' and Manufacturers' Associations, 1923.)

This work has been written in continuation of the author's "Brazilian Cotton," a notice of which appeared in this BULLETIN (1922, **20**, 267). It gives an account of Mr. Pearse's second journey in Brazil and deals principally with the conditions in Ceará, Maranhão and Pará, brief reference being also made to Pernambuco, Parahyba and Rio Grande do Norte. The chief features of the cotton growing industry of North Brazil are summarised in the last chapter, which consists of an article on "Brazil and her Cotton Potentialities," reprinted from the special cotton number of the *Manchester Guardian Commercial* of July 19, 1923.

It is stated that the possibilities of the extension of cotton production in Brazil are fully realised by the Brazilian Government, who are making a serious endeavour to render the country productive of an abundant supply of cotton for the world's markets. Attention is being devoted to seed selection and the production of pure seed for planting, and the marketing of the cotton is being improved by the establishment of exchanges and the employment of qualified graders. Although the supply of labour in the cotton areas is not large, it is regarded as ample for the immediate future, and it is anticipated that when the huge irrigation works which are being constructed in Ceará are completed, there will be an influx into that State of emigrants from other parts of Brazil and, to some extent, from Europe.

The book is full of interest, and is provided with some excellent illustrations and useful maps.

COTTON SPINNING CALCULATIONS. By Thomas Thornley, Head of the Spinning Department, Technical Schools, Bolton. Fifth Edition. Pp. xii + 472, 8vo, 7 × 5. (Manchester and London: John Heywood, Ltd., 1923.) Price 7*s*. 6*d*.

This work describes and illustrates the methods of making calculations relating to all the machines of a cotton-spinning mill, the most important being those

appertaining to speeds, drafts, change pinion for draft, twist wheels, speed wheels, builder wheels, twist per inch, and production.

In the new edition, the whole of the matter has been revised and brought up to date, and about 80 pages of new examples have been added, with a view to meeting the modern demand for examples and descriptions dealing with textile mathematics and textile mechanics.

The book is illustrated with a number of excellent figures and diagrams, and will be indispensable to all students of cotton spinning, as well as to mill owners, managers, foremen and others engaged in the cotton spinning factory.

SUGAR MACHINERY: A DESCRIPTIVE TREATISE DEVOTED TO THE MACHINERY AND PROCESSES USED IN THE MANUFACTURE OF CANE AND BEET SUGARS. By A. J. Wallis-Tayler, A.M.I.C.E. Pp. xvi + 410, 8vo, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: William Rider & Son, Ltd., 1924.) Price 12*s.* 6*d.*

This work gives an account of the various classes of plant and machinery employed in sugar factories, including those used for the extraction of the juice and its clarification and concentration and for the refining of the sugar. The machines are well described and illustrated, and the book will doubtless be of service to those interested in the equipment and management of a sugar factory.

It is unfortunate that the author did not confine the work to the subject of machinery, instead of attempting to deal with the chemistry of sugar and the morphology of the sugar cane, as the portions of the book devoted to these matters are not only inadequate, but in large part either unintelligible or grossly misleading. For example, although on page 3 the chemical formula for sucrose is correctly quoted as $C_{12}H_{22}O_{11}$, in the following pages it is repeatedly given as $C_{12}H_{11}O_{11}$, and, on page 5, acetone is referred to as C_3H_3O (instead of C_3H_6O). The following remarkable statement is made on page 4, regarding the complex mixture of substances known as caramel: "Crystallised cane-sugar and barley sugar consists of $C_{12}H_{11}O_{11}$; if, however, heated to temperatures between 300° Fahr. and 400° Fahr. two equivalents of water are lost, and a black deliquescent substance known as caramel is formed consisting of $C_{12}H_9O_9$." Again, on page 6 we read, "the formula for anhydrous cane sugar is $C_{12}H_9O_9$, and that for crystallised sugar, $C_{12}H_9O_9.2HO$." In general it appears that the author has derived much of his information on the chemistry of

sugar from works published in the early part of the last century.

The botanical information is almost equally grotesque. The following extract from the description of the sugar cane on pages 15–16 will suffice to illustrate this:—"The stole consists of two parts, one of which is formed of several peculiar joints or radicles, numbering from five to seven, placed very close together, and having at their surface rows of small points, which are elements of roots. These radicles are separated from each other by a leaf known as the radicle leaf. This is what is called the primitive stole, which, however, being insufficient for a numerous filiation of joints, there also exist several rows of points or elements of roots on the cane-joints, forming with the joints from which they issue a secondary stole, which forms roots until the joints are in sufficient number and have strength to put forth and sustain the joints which are to follow them and form the stalk. This secondary stole becomes very strong and serves apparently for the filiation of the remaining joints.

"The roots issue from the development of the sap-vessels which are disposed in concentric rays round each point on the surface of the joint."

These examples, which might easily be multiplied, show that the user of the book would be wise to ignore the first two chapters and turn for information on the subjects with which they deal to one of the many good and trustworthy textbooks that are now available.

PULPWOOD AND WOOD PULP IN NORTH AMERICA. By Royal S. Kellogg. Pp. xii + 273, 8vo, $9\frac{1}{2} \times 6\frac{1}{4}$. (London: McGraw-Hill Publishing Co., Ltd., 1923.) Price 20s.

The enormous pulp and paper industries of North America are endangered by the continuous consumption of the raw material without adequate steps being taken to ensure a permanent supply. The main object of the present work is to point out this danger and to emphasise the necessity of maintaining the American timber resources on a satisfactory basis.

The book is divided into four parts. The first, dealing with wood pulp, traces the history of the industry, gives a brief description of the processes of manufacturing mechanical, sulphite, soda and sulphate pulps, and affords statistics of wood pulp manufacture and paper production in the United States, Canada and Newfoundland.

The second part is concerned with pulpwoods, and discusses the methods of logging, the units of measurement employed, the various grades of pulpwood, the quantities

used in North America in the different processes of pulping, and the kinds of wood employed, together with their properties and the regions in which they are produced.

In the third part, consideration is devoted to the various forest regions of North America, the available supply of timber in the United States, Canada and Newfoundland, and the question of forest ownership.

The fourth part, dealing with timber production, lays stress on the need for forestry and particularly for re-afforesting the regions which have already been denuded, refers to the methods of forestry, the risks due to fire, storms, and attack by insects and fungi, the costs of the operations, and the need for a national policy to secure continuous forest production.

The fifth part, entitled " A Permanent Industry (?) " consists of a short chapter emphasising the fact that if the North American pulp industry is to be permanent, every possible effort must be made to grow more wood, as it is impossible to obtain any considerable proportion of the requirements from any other part of the world.

It is stated in the Preface that if the final result of the book is " to promote a better understanding of the part played by the forest in supplying an indispensable factor in modern life, the author will deem his purpose accomplished."

The book is well written, and is provided with numerous excellent diagrams and illustrations, together with several statistical and other useful appendixes.

THE MANUFACTURE OF PULP AND PAPER: A TEXT-BOOK OF MODERN PULP AND PAPER MILL PRACTICE. VOL. IV. MANUFACTURE OF PAPER. Pp. xiii + 541, 8vo, 9½ × 6¼. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) Price 25*s*.

This is the fourth of a series of five volumes which bring together the fundamental subjects of mathematics and elementary science and the principles and practice of pulp and paper manufacture.

In view of the difficulty of finding textbooks suitable both for classes and for private study, the Committee on Education for the Technical Section of the Canadian Pulp and Paper Association and the Committee on Vocational Education for the Technical Association of the (U.S.) Pulp and Paper Industry appointed a Joint Executive Committee to proceed with plans for the preparation, publication and distribution of textbooks designed to provide for preliminary instruction in fundamental mathematics and

elementary science, as well as in the manufacturing operations involved in modern pulp and paper mill practice. This Joint Committee appointed an editor and instructed him to organise a staff of authors consisting of the best men available in the various branches, each to contribute a section dealing with his special part of the subject. As a result of this enterprise the five volumes referred to above have been prepared. These are as follows: Vol. 1, *Mathematics, How to Read Drawings, Physics*; Vol. 2, *Mechanics and Hydraulics, Electricity, Chemistry*; Vol. 3, *Preparation of Pulp*; and Vols. 4 and 5, *Manufacture of Paper*. Each volume is divided into a number of sections, each separately paged; these several sections are being issued in pamphlet form for the benefit of students who wish to study one part at a time, and for convenience in the class-room.

Volume IV, now under consideration, consists of the following sections: I, Preparation of Rag and Other Fibres, by E. C. Tucker, A.B.; II, Treatment of Waste Papers, by Ed. T. A. Coughlin, B.S., Ch.E.; III, Beating and Refining, by Arthur B. Green, A.B., S.B., with bibliography by C. J. West, Ph.D.; IV, Loading and Engine Sizing, by Ross Campbell, B.S., and Judson A. DeCew, B.A.Sc.; V, Colouring, by the Dyestuff Committee of the Technical Association of the (U.S.) Pulp and Paper Industry; VI, Paper-making Machines, by J. W. Brassington.

The work has been carefully written, and gives a clear description of the various processes of paper-making and of the machinery and equipment of the mill. It is provided with a wealth of excellent illustrations and diagrams, and at the end of each section is a short examination paper on the subjects dealt with. The book will be invaluable to all students of paper-making, and also of great service as a work of reference in the paper mill.

Oleaginous Products and Vegetable Oils. Production and Trade. Pp. xxxiv + 511, 9½ × 7. (Rome: International Institute of Agriculture, 1923.) Price 12s.

The success that attended the publication of a similar volume in 1921 (*Produits Oléagineux et Huiles Végétales*, see this Bulletin, 1922, **20**, 269) has induced the International Institute of Agriculture at Rome to compile the present volume, which is written in English. In this edition the information that appeared in the earlier French one is supplemented and brought up to date. The book gives tabulated statistics of the areas and yields of the chief crops of oil-bearing plants, of the production of

vegetable oils, and of the trade in oleaginous products and vegetable oils.

The volume is divided into two parts. The first part (pp. 1–402) is drawn up on the basis of countries and gives statistics of the areas devoted to oil-yielding plants and of the trade in their products for each country examined (170 in all). The other part (pp. 403–506) comprises recapitulatory tables of areas and yields of the chief oil-yielding crops, together with import and export figures for their products. Owing to the absence of reliable data for other products the recapitulatory tables of areas and production are confined to cotton seed, linseed, hemp seed, rape seed and olives, though the trade data in this section include those of almost all the chief oilseeds and oils. Figures are given, in the case of the areas under cultivation, for the last fifty or sixty years, while in respect of trade and the production of oils, only the last ten years or so are reviewed.

An introductory chapter includes a general survey of the principal crops, sections being allocated to cotton seed, rape seed, linseed, ground nuts, soy beans, sesame seed, olives, coconuts and the oil-palm.

The data published in this book show that the production of oilseeds and oils has increased vastly during the last fifty years. Cotton seed, linseed and ground nuts have shown large increases, and the cultivation of the sunflower in Russia has been greatly extended. Other oilseeds which show an augmented production are soy beans and rape seed. The cultivation of the olive appears to have remained stationary, while that of coconuts and the oil-palm has been developed immensely, and these palms have now become most important factors in the total production of oil-yielding material.

The International Institute of Agriculture is to be congratulated on the production of this book, which has entailed an enormous amount of work, including reference to over 2,000 publications.

The Examination of Hydrocarbon Oils and of Saponifiable Fats and Waxes. By Professor Dr. D. Holde. Authorised Translation from the Fifth German Edition by Edward Mueller, Ph.D. Second English Edition. Pp. xix + 572, 9½ × 6½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Limited, 1922.) Price 30s.

This volume is a new English edition of Dr. Holde's well-known work and has been almost entirely re-written, being based on the fifth German edition. The scope of

the book comprises a description of the general methods for the analysis of petroleum and petroleum products, lubricants, natural asphalt, ozokerite, tars from various bituminous materials, saponifiable oils and fats (and the industrial products obtained from them), and waxes. Each section of analytical procedure is preceded by a discussion of the industrial importance and technical use of the material in question.

A new introductory chapter has been included on the general physical, physico-chemical and chemical methods commonly in use in the examination of the various materials ; while other new sections of the book are concerned with electrical tests, the heat of fusion, graphite lubrication, surface tension, cumarone and other artificial resins, and with rosin size. A short résumé is given of the various materials used by the Germans in the war as substitutes for linseed oil varnish, resins, soaps and lubricants. The final chapter is devoted to physico-chemical tables.

The properties of the materials dealt with, and the chemical reactions and industrial data, are as far as possible condensed in the form of tables, thus enabling the author to include a vast amount of information in the book. For more detailed information on any item, the reader is advised to consult the original papers and the larger treatises, and with this end in view the work is furnished with a large number of references.

The book is printed in clear type on good paper, with 135 text figures, and is provided with both author and subject indexes. It should prove very useful to those engaged in the examination of mineral, vegetable and animal oils and fats, and products derived from them.

VARNISHES AND THEIR COMPONENTS. By Robert Selby Morrell, M.A., Ph.D., F.I.C. Pp. xii + 361, 8vo, 8½ × 5¾. (London: Henry Froude and Hodder & Stoughton, 1923.) Price 25s.

This book has been compiled with the object of presenting a summary of recent advances in the study of varnishes and their components. For many years most of the literature on the subject has been supplied by America and Germany, the number of contributions by British workers being noticeably small. It is to be regretted that in this country there is no organised research in this industry, especially when it is considered that, twenty or thirty years ago, the manufacture of varnish in America was conducted on a comparatively small scale,

whilst, according to the author, the first varnish factory was established in England as early as 1790.

The book commences with an introduction on the history of varnishes from earliest times, due recognition being given to the incomparable lacquer work of the Japanese.

The first half of the book deals with the components of varnishes, including linseed oil and other drying oils, semi-drying oils, the principal resins of commerce, and varnish solvents.

The second part of the book is concerned with the varnishes themselves. A detailed account is given of the general methods employed in the manufacture of oil varnishes, and of the maturing of varnishes, their filtration, storage, and application; useful information is also supplied regarding the properties and defects of varnishes. A large number of recipes are given for the preparation of various types of oil and spirit varnishes, and their general properties are discussed. Methods for the examination and estimation of the constituents of oil varnishes are described. The book is well illustrated, is supplied with references to recent original publications on varnish oils and resins, and will be of value to all interested in the varnish industry.

THE CHEMISTRY OF PAINTS, PIGMENTS AND VARNISHES. By J. Gauld Bearn, M.Sc., A.I.C. Pp. x + 277. 10 × 7½. (London: Ernest Benn, Ltd., 1923.) Price 30s.

This work has been written for the purpose of supplying works managers and students with a general survey of the paint and varnish industry, together with an account of modern technical processes and the chemistry of the raw materials employed.

The first section (which occupies only twenty-six pages) deals with the subject of paints, and gives an outline of the methods of manufacture and the composition and properties of white and coloured paints, enamels, anti-corrosive and anti-fouling paints, and of various distempers. A short account of the methods of analysing paints is also supplied.

In the second part of the book the various inorganic and organic pigments and lakes are considered in some detail, and particulars are given of their composition, properties, manufacture and uses. Methods of analysis and evaluation are described, a special chapter being devoted to the determination of the following physical properties of pigments: specific gravity; fineness; colour, brightness and cleanness of tone; oil absorption; strength; hiding power, covering power and permanency.

The third section is concerned with varnishes, lacquers and japans, and a good account is given of their manufacture and of the various raw materials employed, including colophony or rosin, balsams, soft resins, shellac, and fossil resins; celluloid, nitrocellulose, cellulose acetate and synthetic resins; drying oils, such as linseed oil and wood oil; solvents and diluents, viz. turpentine, alcohol and other volatile liquids; driers, siccatives and terebines.

The work is well illustrated, and is provided with an appendix containing some useful tables and a good index. It will no doubt prove of service to all interested in this branch of technology, and especially to workers in the laboratories of paint and varnish works.

LEAD. By J. A. Smythe, Ph.D., D.Sc. Pp. vi + 343, 8¾ × 5¾. (London: Longmans, Green & Co., 1923.) Price 16*s*.

This book, one of the series of Monographs on Industrial Chemistry, edited by Sir Edward Thorpe, C.B., LL.D., F.R.S., provides in a handy form a large amount of information on the chemistry and metallurgy of lead, without giving too much technical detail. It starts with a long but interesting history of lead and its products, their preparation and uses, from the earliest times. Following this are descriptions of lead deposits occurring under different geological conditions, the metal associates of lead, the tenor of ores, gangue minerals, and minerals of lead, including those that are radio-active. Brief accounts of different occurrences of lead ore, both British and foreign, are given next. The few statistics of the world's production and consumption of lead which are supplied are somewhat belated, being for the year 1913. The book does not deal with the mining and dressing of lead ores.

Roasting and smelting are treated in detail, and wherever it is possible at each step the chemistry of the reaction is described. Primary and secondary roasting reactions, which occur with complex mineral products, and the effects of various catalysts on roasting, are discussed. Descriptions follow of different rabbled furnaces, and of the Dwight-Lloyd and Huntington-Heberlein processes. Various forms of reverberatory smelting—English, Silesian and Carinthian—and of blast furnace smelting are described and illustrated in detail, but in some cases the illustrations would have been rendered more valuable by the addition of dimensions or scales.

The various processes for the softening and desilverising of lead and the English and German cupellation methods

are well treated. The collection of lead-bearing dust, by condensation, by bag filtration and by electrostatic precipitation, is next described. The uses and properties of lead and its alloys, both physical and chemical, and the connection between lead and the radio-active changes of uranium and thorium minerals, are given at length, as well as the preparation and properties of oxides, carbonates and other compounds of lead. A short chapter on lead-poisoning concludes the volume.

The book has been well written and indexed, and will serve as an excellent introduction to larger works. The printing of the volume, which has been carried out in Germany, has a distinctly foreign appearance, and is not up to the standard of that of earlier volumes of the series.

ENGINEERING NON-FERROUS ALLOYS. By L. Aitchison, D.Met., and W. R. Barclay. Pp. xx + 300, 8vo, 8½ × 5½. (London: Henry Frowde and Hodder & Stoughton, 1923.) Price *21s.*

The first part of this book deals generally with non-ferrous alloys and discusses their constitution, mechanical properties, and the methods of casting, working, and heat treatment. Much useful information is also given on the methods of testing and the indications afforded by the results obtained.

The second part of the volume contains a detailed account of the alloys of copper, aluminium, and nickel, a separate chapter being devoted to other non-ferrous alloys, including bearing metals, solders, fusible alloys, die castings and alloys of magnesium. This section provides much useful information, the value of which is enhanced by reference to the results of practical tests, showing the effects on the physical properties of the alloy of impurities and variations of heat treatment.

The book concludes with a useful chapter on the choice and specification of a non-ferrous alloy, and is illustrated with numerous graphs, diagrams, and photo-micrographs.

The authors have evidently incorporated results of their personal experience, and the work supplies an up-to-date résumé of recent progress in this branch of technology.

TECHNICAL METHODS OF ORE ANALYSIS. By Albert H. Low, Sc.D. Ninth Edition. Pp. xlix + 348, 8vo, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price *17s. 6d.*

The fact that this book has reached its ninth edition shows it has met the needs of a wide circle of readers.

As in previous editions, the author gives a good description of the standard methods for estimating the principal constituents of ores, but the present volume contains several new features, including the means of training students in rapid technical analytical methods, and a specimen lecture.

The book appears to have been considerably rewritten, and much matter formerly in the appendix now appears in its appropriate position in the body of the work. The book will be of continued service to both teachers and technical chemists.

PULVERISED AND COLLOIDAL FUEL. By J. T. Dunn, D.Sc., F.I.C. Pp. 197, 8vo, 9¾ × 7¼. (London: Ernest Benn, Ltd., 1924.) Price 25*s*.

The great majority of works on the subject of pulverised fuel have appeared in America; this one has been written by an English chemical engineer. It is divided into two parts—the first, of 174 pages, on pulverised fuel, and the second, of 19 pages, on colloidal fuel.

The introductory pages treat of the chemistry and physics of the combustion of coal in all forms. The history of the use of powdered coal from 1831 onwards follows, and then, in order, the coarse crushing, drying, and pulverising of coal, and its transport, are fully discussed, the different classes of machinery used and the "lay-out" of plants being elucidated by many drawings and photographs. The suitability for pulverising of different classes of fuel, including both high- and low-temperature coke, as well as the difficulties of ash disposal, are considered in detail. Many examples are given of the use of the fuel in industry, together with descriptions of its employment in reverberatory copper smelting, open-hearth steel furnaces, steel ingot heating, puddling furnaces, steam raising, locomotives and marine propulsion.

The smaller section of the book, on so-called colloidal fuel, deals with the suspension of finely powdered coal in oil of suitable viscosity, experimental work that has been done in this sphere, and the results which have followed. The use of "fixateurs" or stabilisers and of "peptising" agents in preventing or reducing the settling-out of the coal is described.

The book is clearly printed and well illustrated, and as the subject has been treated with great lucidity, it will be of interest even to non-technical readers.

Low Temperature Carbonisation of Bituminous Coal. By Andrew McCulloch, A.I.C., and Neville Simpkin, M.Sc. Pp. xii + 248, 8vo, 9 × 6. (London: H. F. and G. Witherby, 1923.) Price 18s.

Processes for producing smokeless fuel, suitable for domestic use, by distilling coal at temperatures lower than those generally employed at gas works, have been before the public for many years past, but until recently have met with little favour. The urgent demand for fuel oils during the war led to considerable technical progress being made with such processes, which give a relatively large yield of liquid oils.

The volume includes a good account of the majority of the low-temperature carbonisation processes which have been suggested, and indicates the progress which has been made in placing certain of them on a commercial basis. The processes are considered from both the engineering and physico-chemical standpoints.

The tar (or "oils") yielded by coal when subjected to low-temperature distillation differs considerably from that obtained when the material is carbonised in the ordinary gas works or coke-oven retort or in gas producers, and hence the useful comparisons made between these products, with regard to yield and composition, are of special interest. The somewhat complex composition of the several types of low-temperature tars is considered in detail.

The book is essentially practical, and the authors have drawn on most available sources of information, references to which are given. It can be recommended to all interested in this branch of fuel technology.

Modern Gasworks Chemistry. By Geoffrey Weyman, D.Sc., F.I.C. Pp. ix + 184, 8vo, 9¾ × 7¼. (London: Benn Bros., Ltd., 1922.) Price 25s.

This book, which embodies the results of the author's personal experience as chief chemist to the Newcastle-on-Tyne and Gateshead Gas Co., describes the methods of chemically controlling the processes used in the manufacture of gas and the purification of certain by-products.

Separate chapters are devoted to coal, carbonisation, coke, maintenance of heats, refractory and insulating materials, tar, ammonia, oxide purification, town gas, water gas, steam raising and water supply, and lubricants.

The source and characteristics of the various products of gas manufacture are considered together with numerous methods of analysis in relation to the control of the operations. A useful bibliography is given at the conclu-

sion of each chapter. The book should be of service to all interested in gas manufacture.

RAW MATERIALS FOR THE MANUFACTURE OF SULPHURIC ACID AND SULPHUR DIOXIDE. By W. Wyld. Pp. xiii + 558, 8vo, 9 × 6. (London: Gurney & Jackson, 1923.) Price 30s.

The last English edition of Lunge's *Manufacture of Sulphuric Acid and Alkalis* appeared in 1913, but the author intimated that he could not undertake the preparation of later editions, and it was therefore arranged that the present edition should be prepared under the general editorship of Dr. A. C. Cumming. It is now being issued as a number of volumes, each on a special subject, arranged in accordance with modern developments and written by a separate author.

The present volume (No. 1 of the series) comprises five chapters, dealing with (i) the historical aspect, (ii) raw materials, (iii) properties and analysis of the technically employed oxides of sulphur, (iv) production of sulphur dioxide, and (v) dry-products in the manufacture of sulphuric acid.

A glance at the copious references will indicate how thorough the revision has been, but it is to be regretted that in this, as in previous editions, a number of patented processes described are unaccompanied by any indication as to whether they have ever been used commercially.

Although doubtless intended for those particularly concerned in the manufacture of sulphuric acid and allied products, the book contains much information of interest to others.

Thus, for example, we find useful and practical information regarding the occurrence, properties, production and washing of sulphide ores, the briquetting of roasted pyrites and the recovery of copper from such material. Many readers will find the pages on the action of sulphuric acid on metals of special service, whilst others will be interested in the carefully described analytical methods.

The present work will undoubtedly prove of service to a wide circle of readers, and the succeeding volumes of the series will be awaited with interest.

OIL WELL DRILLING METHODS. By Victor Ziegler, A.M., Ph.D. Pp. xii + 257, 7½ × 5½. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 15s.

This work is described in the preface as "a pocket handbook containing a brief description and explanation of

the methods and tools used in drilling oil wells, and is intended to serve as an introduction to the subject." To students and others who do not possess, or have not access to, the larger works on the subject it should prove useful. The information given in the text is concise and accurate, and the figures, which number 180, are clearly drawn.

Emergency Water Supplies: for Military, Agricultural and Colonial Purposes. By A. Beeby Thompson, O.B.E., M.I.Mech.E., M.Inst.M.M., F.G.S. Pp. xii + 180. 8¾ × 6. (London: Crosby, Lockwood & Son, 1924.) Price 21s.

The supplying of large quantities of water at short notice is a problem which has to be faced in connection with the passage of troops through arid country and the agricultural development of such land. This problem has been studied by the author, who was attached to the Headquarters Staff of the Mediterranean Expeditionary Force from 1915 to 1919. The present book is based on his experience with this Army, and is therefore essentially a description of the operations undertaken for supplying water to armies in the Middle East, while much of the data has been extracted almost verbatim from the author's official report to the War Office.

The chief chapter in the book is on the subject of drive tube wells, and deals with the uses and limitations of this system; the description of the apparatus used; the process of driving a tube well; the testing of yields; the selection of suitable sites; the advantages of grouping tube wells; and the results of tube well work on the Salonika front.

In a section on the drilling of wells the geological conditions essential for the successful drilling of deep wells are considered; the apparatus employed and the procedure to be followed are described; and tables are included giving the cost and records of drilling wells in the Salonika area.

Other chapters are devoted to the principles of hydrology and of hydrography, with special reference to Macedonia; the development of water sources by means of wells, filtration and the utilisation of springs; and on the selection of pumping equipment and the character of waters.

The volume is clearly printed on good paper, is excellently illustrated with forty-five photographic reproductions and fifty-one text-figures, and is furnished with an index.

CANNED FOODS IN RELATION TO HEALTH. By William G. Savage, B.Sc., M.D. (Lond.), D.P.H. Pp. vi + 146, 8½ × 5½. (Cambridge: At the University Press, 1923.) Price 8s. 6d.

This book, issued as a volume of the Cambridge Public Health Series, consists of the Milroy Lectures for 1923 as delivered to the Royal College of Physicians, with slight amplification. During the last four years, the author has been engaged, with the help of other workers, in a systematic and detailed laboratory study of canned foods, and has also investigated the methods of manufacture practised in this country, the United States and Canada, and the supervision exercised over the preparation, importation and sale. The results of this work have formed the basis of the present volume, and have been supplemented from the literature available on the subject.

In the preface the author refers to the increasing extent to which canned foods are consumed, and asks, "Is this drastic change one to be encouraged whole-heartedly or is it, like so many modern contrivances, fraught with its own menace and disadvantages which have to be eliminated or at least guarded against before its benefits can be reaped?" The object of the book is to supply an answer to this question, and the subject is systematically treated from this standpoint.

The first two lectures discuss the principles involved in the methods of manufacturing canned foods, the supervision and control exercised, the bacteriology of canned foods, and the changes which occur in sound food after canning. The third lecture deals with poisoning outbreaks due to canned foods, including botulism and other infection due to specific bacteria, the presence of animal parasites, chemical contamination, and the effect of canning on the vitamins of different foods.

The author concludes that although the use of canned foods entails definite and special risks, these risks are not large, and in most cases can be readily guarded against. Moreover, canned foods are undoubtedly safer than fresh foods, as the latter are subjected merely to haphazard and totally inadequate control.

There are two appendixes to the book, consisting of Reports made by the author to the Canned Food Committee of the Food Investigation Board. The first of these deals with the principles involved in the processing of canned foods, *i.e.* the final heating given after the can has been hermetically sealed and designed to prevent subsequent bacterial decomposition. The second Report discusses laboratory methods for the examination of canned foods.

The book is of much value, as it supplies information of great importance to the health of the community and makes a number of useful recommendations relating to the preparation, storage and distribution of canned foods. It is written in an interesting manner, and is provided with a classified bibliography.

INVERTEBRATE ZOOLOGY. By Harley Jones Van Cleave, Associate Professor of Zoology, University of Illinois. Pp. xvi + 259, 8vo, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1924.) Price 15*s*.

In view of the paucity of works on the zoology of the invertebrates suitable as textbooks for students, the author has compiled the present treatise which should be serviceable both in the class-room and for general purposes of reference. It is published in the useful series of McGraw-Hill Agricultural and Biological Publications which are being issued under the editorship of Dr. Charles V. Piper.

The work lays particular emphasis on the biological principles and generalisations of each group of invertebrates, assuming that those for whom it is designed already possess an elementary knowledge of zoology.

The introductory chapter deals in a most interesting manner with the system of classification of the invertebrates and the methods of reproduction met with in these groups of animals. In the succeeding chapters, the various non-chordate phyla are discussed in the following order: Protozoa, Porifera, Coelenterata, Ctenophora, Plathelminthes, Nemathelminthes, Trochelminthes, Molluscoidea, Echinoderma, Mollusca, and Arthropoda. At the end of each chapter a useful list of general references to the literature of the subject is provided.

The book is profusely illustrated with excellent diagrams, is furnished with a good index, and can be confidently recommended to all students of zoology.

SOME STUDIES IN BIO-CHEMISTRY. By some students of Dr. Gilbert J. Fowler, D.Sc., F.I.C., Indian Institute of Science. Pp. iv + 197, 8vo, $9\frac{1}{2} \times 6\frac{1}{4}$. (Bangalore: The Phœnix Printing House, 1924.)

This collection of short papers, embodying the results of investigations carried out by certain of Dr. Fowler's students, has been compiled and dedicated to Dr. Fowler as a mark of appreciation on his retirement from the chair of bio-chemistry at the Indian Institute of Science, Bangalore.

The papers cover a wide range of subjects and illustrate the variety of work conducted in the bio-chemical

laboratories of the Institute. They include studies of the fermentation organisms concerned in the production of acetone, vinegar, mohua spirit and other materials; sewage control and utilisation; nitrification of the soil; lac, its formation, chemistry, adulteration, and the utilisation of its by-products; the rôle of enzymes in the chemistry of leather manufacture; the utilisation of tannery waste; the preparation of cutch; and similar subjects. There is also an interesting paper by Dr. F. Marsden on the retting of coir, further reference to which is made on page 77 of this BULLETIN.

A photograph of Dr. Fowler is printed as a frontispiece to the book.

BOOKS RECEIVED

THE RESOURCES OF THE EMPIRE SERIES. VOL 5. RUBBER, TEA AND CACAO, WITH SPECIAL SECTIONS ON COFFEE, SPICES AND TOBACCO. Compiled and edited by W. A. Maclaren. Pp. xx + 334, 10 × 7½. (London: Ernest Benn, Limited, 1924.) Price 21*s.*

THE RESOURCES OF THE EMPIRE SERIES. VOL. 10. COMMUNICATIONS. By W. Tetley Stephenson. Pp. xli + 180, 10 × 7½. (London: Ernest Benn, Limited, 1924.) Price 21*s.*

GUIDE TO RHODESIA FOR THE USE OF TOURISTS AND SETTLERS, WITH ILLUSTRATIONS, MAPS, AND PLANS. Second and Revised Edition. (London: Beira and Mashonaland and Rhodesia Railways, 1924.) Price 2*s.* 6*d.*

INDIA OF TO-DAY. VOLUME IV. INDIA'S MINERAL WEALTH. By J. Coggin Brown. Pp. 121, 7½ × 5. (London: Oxford University Press, 1923.) Price 3*s.*

ECONOMIC GEOGRAPHY. By R. H. Whitbeck and V. C. Finch. Pp. x + 558, 9 × 6. (New York: McGraw-Hill Book Company, Inc., 1924.) Price 17*s.* 6*d.*

THE HANDICAP OF BRITISH TRADE. With special regard to East Africa. By W. H. Hooker. Second Edition. Pp. xiii + 207, 7½ × 5. (London: John Murray, 1924.) Price 3*s.* 6*d.*

LUCERNE CULTURE IN SOUTH AFRICA. By Hubert D. Leppan, B.Sc.A. Pp. 68, 8½ × 5½. (South Africa: Central News Agency, Ltd.; London: Gordon and Gotch, Ltd., 1924.) Price 6*s.*

THE COCOA AND CHOCOLATE INDUSTRY. By Arthur W. Knapp, B.Sc., F.I.C. Pp. xii + 147, 7 × 5. (London: Sir Isaac Pitman & Sons, Ltd., 1923.) Price 3*s.*

MODERN WOOD-WORKING MACHINERY. By Stafford Ransome, M.Inst.C.E. Pp. xix + 385, 8½ × 5½. (London: William Rider and Son, Ltd., 1924.) Price 12s. 6d.

THE TEXTILE RECORDER YEAR BOOK, 1924. Compiled and edited by Frank Nasmith. Pp. ciii + 812, 7½ × 5½. (Manchester: John Heywood, Limited, 1924.) Price 7s. 6d.

DIRECTORY OF PAPER MAKERS OF THE UNITED KINGDOM, 1924. Pp. 276, 10½ × 7½. (London: Marchant Singer & Co., 1924.) Price 5s.

SANDS AND CRUSHED ROCKS. By Alfred B. Searle. Vol. I. Their Nature, Properties and Treatment. Pp. xiv + 475. Vol. II. Their Uses in Industry. Pp. ix + 281, 8½ × 5½. (London: Henry Frowde & Hodder & Stoughton, 1923.) Price complete, 52s. 6d.

A TEXTBOOK OF PETROLEUM PRODUCTION ENGINEERING. By Lester Charles Uren. Pp. vii + 657, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1924.) Price 30s.

GAS MANUFACTURE. By W. B. Davidson, M.A., Ph.D., F.I.C. Pp. viii + 464, 8½ × 5½. (London: Longmans, Green & Co., 1923.) Price 21s.

TESTED METHODS OF MINERAL ANALYSIS. By B. T. Kitto. With a Foreword by Benedict Kitto, F.I.C., F.G.S., Hon. M.I.M.M. Pp. 127, 7½ × 5. (London: H. F. & G. Witherby, 1923.) Price 7s. 6d.

DIZIONARIO DI MERCEOLOGIA E DI CHIMICA APPLICATA. By Prof. Dr. G. Vittorio Villavecchia in collaboration with Professors Dr. G. Fabris, Dr. G. Rossi, Dr. A. Bianchi and Dr. R. Belasio. Fourth Edition. Volume II, Damiana-Mussena. Pp. 874 to 1679, 10 × 7. (Milan: Ulrico Hoepli, 1924.) Price L. 35.

COLLOID CHEMISTRY: Wisconsin Lectures. By The Svedberg. Pp. 261, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1924.) Price $3.00.

CHEMISTRY OF THE RARER ELEMENTS. By B. Smith Hopkins. Pp. vii + 376, 8½ × 5½. (New York: D. C. Heath and Co.; London: George G. Harrap & Co., Ltd., 1923.) Price 15s.

CHEMICAL SYNONYMS AND TRADE NAMES. By William Gardner. Pp. 271, 10 × 6½. (London: Crosby Lockwood & Son, 1924.) Price 25s.

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

THE CHARACTERS OF INDIAN MYROBALANS

In connection with an enquiry on the marketing of Indian myrobalans conducted during the war by the Special Committee of the Indian Trade Enquiry on Hides and Tanning Materials, the report on which has since been published by Mr. John Murray, it was suggested to the President of the Forest Research Institute that an investigation should be made to determine the amounts of tannin in the fruits of different varieties of myrobalans. A previous examination at the Imperial Institute of a large number of samples of myrobalans had shown that the amount of tannin present varies considerably, and it seemed desirable therefore to ascertain whether this is due to the variety of tree or to the locality in which the fruits are grown.

In response to this suggestion thirty-seven samples of myrobalans were forwarded to the Imperial Institute by the Forest Botanist, at Dehra Dun. The consignment comprised, according to the descriptions on the labels, one sample (No. 1) of (probably) *Terminalia citrina*, Fleming; one (No. 13) of an unnamed species of Terminalia; two (Nos. 4 and 5) of *T. tomentella*, Kurz; four (Nos. 12, 18, 20 and 28) of *T. pallida*, Brandis; and twenty-nine of *T. Chebula*, Retz. With the exception of *T. Chebula*, therefore, the samples were too few to permit of the results of their examination being regarded as fully representative of the species concerned.

TABLE A

Sample.	Label.	Weight of sample.	Colour.	Appearance.	Average length.	Average diam.	Average weight.
		lb.			inches.	inches.	grams.
I	*Terminalia citrina* (probably). From Lakhimpur Division, Assam.	14½	Dark greyish to reddish-brown.	Generally shrunken. Fairly prominent ridges.	1·12	0·47	2·26
II	*Terminalia Chebula*, Retz. (Long, narrow fruit.) From Poona Division, Bombay.	7	Fairly light to dark yellowish-brown.	Fairly plump. Fairly prominent ridges, with slight ridges between.	1·11	0·51	2·58
III	*Terminalia Chebula*, Retz. From Central Kanara Division, Bombay.	7½	Fairly light yellowish-brown to light brown.	Fairly plump. Fairly prominent ridges, with slight secondary ridges between.	1·12	0·71	5·84
IV	*Terminalia tomentellá*, Kurz. (Tree No. 1.) From South Pegu Division, Burma.	6	Dark reddish-brown.	Generally very shrunken (irregularly). No ridges evident. The sample was mixed, and some fruits were in very poor condition.	1·19	0·75	2·35
V	*Terminalia tomentella*, Kurz. (Tree No. 2.) From South Pegu Division, Burma.	7½	Dark greyish to reddish-brown	Rather shrunken. Fairly prominent ridges.	1·20	0·54	3·80
VI	*Terminalia Chebula*, Retz. From Ataran Division, Burma.	6½	Dark reddish-brown.	Very shrunken (irregularly). No ridges.	1·12	0·75	5·43
VII	*Terminalia Chebula*, Retz. From Myittha Division, Burma.	6	Yellowish-brown to dark reddish-brown.	Somewhat shrunken. Fairly prominent ridges.	1·01	0·56	2·23
VIII	*Terminalia Chebula*, Retz. (Fruit from Tree No. 2) From Melghat Division, Central Provinces.	13½	Fairly light to dark yellowish-brown.	Somewhat shrunken. Slight ridges.	1·32	0·75	7·56
IX	*Terminalia Chebula*, Retz. From Ranipur Range, Betul Division, Central Provinces.	7	Rather dark yellowish-brown to reddish-brown.	Fairly plump. Slight ridges.	1·16	0·74	5·30
X	*Terminalia Chebula*, Retz. (Harra No. III.) From Saonligarh Range, Betul Division, Central Provinces.	10½	Yellowish-brown to brown.	Somewhat shrunken. Slightly prominent ridges.	1·22	0·68	5·70
XI	*Terminalia Chebula*, Retz. From Bhawargarh Range, Betul Division, Central Provinces.	6½	Fairly light yellowish-brown to reddish-brown.	Fairly plump. Fairly prominent ridges, with secondary ridges.	1·12	0·64	5·14
XII	*Terminalia pallida*, Brandis (White Kadukai). From Chingleput Division, Madras.	7½	Yellowish brown to dark brown.	Plump, some showing fairly deep furrows. Mixed.	1·06	0·54	2·40

XIII	*Terminalia* sp. (Black Kadukai.) From Chingleput Division, Madras.	5½	Yellowish-brown.	Plump. Fairly deep furrows.	1·13	0·56	2·98
XIV	*Terminalia Chebula*, Retz. From West Vellore Division, Madras.	10	Fairly light yellowish-brown to light brown.	Plump. Broad furrows.	1·20	0·65	4·63
XV	*Terminalia Chebula*, Retz. From Tiruvannamallai Range, South Vellore Division, Madras.	7½	Fairly dark brown.	Plump. Slight depressions in some cases.	1·07	0·65	3·08
XVI	*Terminalia Chebula*, Retz. From Polur Range, South Vellore Division, Madras.	11½	Fairly light to dark yellowish-brown.	Variable, from fairly plump to slightly shrunken. Slight ridges.	1·57	0·70	5·04
XVII	*Terminalia Chebula*, Retz. (Tree No. 1 of Polur Range.) Round-fruited. From Polur Range, South Vellore Division, Madras.	8½	Rather dark yellowish-brown.	Plump. Slight furrows.	0·96	0·75	4·64
XVIII	*Terminalia pallida*, Brandis. (White species.) From Chittoor Division, Madras.	10½	Fairly light yellowish-brown with greenish tinge.	Slightly shrunken. Fairly prominent broad ridges, with secondary ridges.	1·00	0·66	4·33
XIX	*Terminalia Chebula*, Retz. (Black species.) From Chittoor Division, Madras.	6½	Rather dark yellowish-brown.	Plump. Slight furrows.	1·00	0·68	3·64
XX	*Terminalia pallida*, Brandis. (Tella Karaka.) Kodur Forest Range, South Cuddapah Division, Madras.	8½	Fairly light yellowish-brown.	Shrunken. Prominent ridges and secondary ridges.	1·01	0·50	2·27
XXI	*Terminalia Chebula*, Retz. (Nalla Karaka.) Kodur Forest Range. South Cuddapah Division, Madras.	7¾	Fairly light yellowish-brown to reddish-brown. Some with greenish tinge.	Fairly plump. Slightly prominent ridges and secondary ridges.	1·18	0·64	5·86
XXII	*Terminalia Chebula*, Retz. (var. *typica* prob.). From North Salem Division, Madras.	9	Fairly light yellowish-brown with greenish tinge.	Plump. Slight furrows.	1·04	0·74	5·05
XXIII	*Terminalia Chebula*, Retz. (Round-fruited White.) From South Salem Division, Madras.	6½	Yellowish-brown.	Plump or slightly shrunken. Slight broad furrows.	1·12	0·84	8·12
XXIV	*Terminalia Chebula*, Retz. (Long-fruited Black.) From South Salem Division, Madras.	7	Yellowish-brown.	Plump or slightly shrunken. Slightly prominent ridges or slight furrows.	1·03	0·57	4·08
XXV	*Terminalia Chebula*, Retz. (Long-fruited Black.) From East Salem Division, Madras.	8	Yellowish-brown.	Plump. Slightly prominent ridges.	0·92	0·63	2·98
XXVI	*Terminalia Chebula*, Retz. (Karunkadukar. Round-fruited White.) From East Salem Division, Madras.	9½	Dull yellowish-brown.	Fairly plump. Slight furrows.	1·08	0·58	3·59

TABLE A (*continued*)

Sample.	Label.	Weight of sample.	Colour.	Appearance.	Average length.	Average diam.	Average weight.
		lb.			*inches.*	*inches.*	*grams.*
XXVII	*Terminalia Chebula*, Retz. (Pedda Karaka.) From Nellore Division, Madras.	6½	Mostly dull yellowish-brown.	Plump to somewhat shrunken. Slight broad ridges.	1·18	0·61	2·48
XXVIII	*Terminalia pallida*, Brandis. (Budda Karaka) From Nellore Division, Madras.	7½	Rather dark yellowish-brown with reddish tinge.	Somewhat shrunken. Fairly prominent ridges and secondary ridges.	0·92	0·54	2·60
XXIX	*Terminalia Chebula*, Retz. From Saharanpur Division, U.P.	7½	Rather dark yellowish-brown to reddish-brown.	Shrunken (regularly). Slightly prominent ridges in some cases.	1·17	0·61	3·68
XXX	*Terminalia Chebula*, Retz. From Dehra Dun Division, U P.	9½	Rather dark yellowish-brown to reddish-brown.	Shrunken. Prominent ridges and secondary ridges.	1·29	0·64	4·63
XXXI	*Terminalia Chebula*, Retz. From Ramnagar Division, U.P.	3½	Yellowish-brown to brown.	Shrunken. Fairly prominent ridges.	1·16	0·66	5·76
XXXII	*Terminalia Chebula*, Retz. (Trees Nos. 2 and 6.) From Kangra Division, Punjab.	4½	Rather dark yellowish-brown to reddish-brown.	Somewhat shrunken (regularly). Prominent ridges.	1·05	0·59	3·76
XXXIII	*Terminalia Chebula*, Retz. (Trees Nos. 1 and 4) From Kangra Division, Punjab.	4½	Rather dark yellowish-brown to reddish-brown.	Somewhat shrunken. Prominent ridges.	1·51	0·76	8·56
XXXIV	*Terminalia Chebula*, Retz. (From Tree No. 3, Dehra Dun.) From Forest Botanist's office, Dehra Dun, U.P. Fruit collected on 22/xi/21.	7½	Rather dark yellowish-brown to reddish-brown.	Somewhat shrunken (regularly). Surface covered irregularly with longitudinal ridges.	1·46	0·67	4·90
XXXV	*Terminalia Chebula*, Retz. (From Tree No. 1, Dehra Dun.) From Forest Botanist's office, Dehra Dun, U.P. Fruit collected on 28/xi/21.	7	Pale yellowish-brown to brown.	Somewhat shrunken (regularly). Surface covered irregularly with longitudinal ridges.	1·22	0·51	3·16
XXXVI	*Terminalia Chebula*, Retz. (From Tree No. 3, Dehra Dun). Collected on 17/vii/21; from Forest Botanist's office, Dehra Dun, U.P.	6½	Dark reddish-brown.	Somewhat shrunken (regularly). Fairly prominent ridges towards narrow end.	1·46	0·61	2·98
XXXVII	*Terminalia Chebula*. Retz. (From Tree No. 1.) Collected on 17/vii/21; from Forest Botanist's office, Dehra Dun, U.P.	7	Dark reddish-brown.	Somewhat shrunken. Fairly prominent ridges.	1·10	0·41	2·46

TABLE B

Sample.	Label.	Composition (expressed on material as received). Moisture.	Insoluble matter.	Extractive matter (non-tannin).	Tannin.	Ash.	Tintometer Readings. Red.	Yellow.	Tannin expressed on material containing 10 per cent. moisture.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.			Per cent.
I	*Terminalia citrina* (probably). From Lakhimpur Division, Assam	7·1	48·5	17·2	27·2	2·4	3·0	10·0	26·2
II	*Terminalia Chebula*, Retz. (Long narrow fruit.) From Poona Division, Bombay	8·4	46·2	13·5	31·9	2·4	1·2	3·6	31·3
III	*Terminalia Chebula*, Retz. From Central Kanara Division, Bombay	8·3	42·6	12·5	36·6	2·0	1·0	3·5	35·9
IV	*Terminalia tomentella*, Kurz. (Tree No. 1.) From South Pegu Division, Burma	7·6	54·1	21·8	16·5	2·7	7·3	37·8	16·1
V	*Terminalia tomentella*, Kurz. (Tree No. 2.) From South Pegu Division, Burma	8·5	54·4	17·6	19·5	2·3	2·8	11·5	19·2
VI	*Terminalia Chebula*, Retz. From Ataran Division, Burma	9·5	47·9	25·2	17·4	2·2	3·0	15·0	17·3
VII	*Terminalia Chebula*, Retz. From Myittha Division, Burma	9·3	56·9	21·7	12·1	2·7	2·6	10·0	12·0
VIII	*Terminalia Chebula*, Retz. (Fruit from Tree No. 2.) From Melghat Division, Central Provinces	9·2	38·1	22·3	30·4	2·4	1·4	5·3	30·1
IX	*Terminalia Chebula*, Retz. From Ranipur Range, Betul Division, Central Provinces	7·9	45·2	14·6	32·3	2·1	1·7	4·6	31·6
X	*Terminalia Chebula*, Retz. (Harra No. III) From Saonligarh Range, Betul Division, Central Provinces	8·9	40·9	13·3	37·1	1·9	0·8	3·3	36·7
XI	*Terminalia Chebula*, Retz. From Rhawargarh Range. Betul Division, Central Provinces	9·1	45·1	11·5	34·3	1·8	0·7	3·0	34·0
XII	*Terminalia pallida*, Brandis. (White Kadukai.) From Chingleput Division, Madras	8·1	50·5	12·5	28·9	2·0	3·0	20·0	28·3
XIII	*Terminalia* sp. (Black Kadukai.) From Chingleput Division, Madras	9·0	52·4	11·4	27·2	2·2	1·0	3·6	26·9
XIV	*Terminalia Chebula*, Retz. From West Vellore Division, Madras	9·1	36·9	11·5	42·5	2·5	0·5	2·0	42·1
XV	*Terminalia Chebula*, Retz. From Tiruvannamallai Range, South Vellore Division, Madras	7·9	49·1	15·5	27·5	2·4	4·9	21·0	26·9
XVI	*Terminalia Chebula*, Retz. From Polur Range, South Vellore Division, Madras	8·9	42·2	12·0	36·9	2·0	1·5	6·1	36·5
XVII	*Terminalia Chebula*, Retz. (Tree No. 1 of Polur Range) Round-fruited. From Polur Range, South Vellore Division, Madras	8·8	37·4	12·7	41·1	1·9	1·3	7·8	40·6
XVIII	*Terminalia pallida*, Brandis. (White species.) From Chittoor Division, Madras	9·5	40·4	12·3	37·8	2·4	0·9	2·6	37·7
XIX	*Terminalia Chebula*, Retz. (Black species.) From Chittoor Division, Madras	8·3	48·8	16·5	26·4	2·3	1·6	8·7	25·6

TABLE B (*continued*)

Sample.	Label.	Composition (expressed on material as received). Moisture.	Insoluble matter.	Extractive matter (non-tannin).	Tannin.	Ash.	Tintometer Readings. Red.	Yellow.	Tannin expressed on material containing 10 per cent. moisture.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*			*Per cent.*
XX	*Terminalia pallida*, Brandis. (Tella Karaka.) Kodur Forest Range, South Cuddapah Division, Madras . . .	9·3	48·5	23·1	19·1	2·4	1·9	7·5	19·0
XXI	*Terminalia Chebula*, Retz. (Nalla Karaka.) Kodur Forest Range, South Cuddapah Division, Madras . . .	9·3	41·6	13·9	35·2	2·2	0·5	2·4	35·0
XXII	*Terminalia Chebula*, Retz. (var. *typica* prob.). From North Salem Division, Madras	10·2	31·6	9·3	48·9	1·8	0·5	1·9	49·0
XXIII	*Terminalia Chebula*, Retz. (Round-fruited White.) From South Salem Division, Madras	9·2	30·7	12·7	47·4	2·1	0·5	2·0	47·0
XXIV	*Terminalia Chebula*, Retz. (Long-fruited Black.) From South Salem Division, Madras	10·4	31·1	11·2	47·2	2·0	0·5	2·0	47·4
XXV	*Terminalia Chebula*, Retz. (Long-fruited Black.) From East Salem Division, Madras	8·9	41·1	8·0	42·0	2·1	0·7	2·4	41·4
XXVI	*Terminalia Chebula*, Retz. (Karunkadukar.) (Round-fruited White). From East Salem Division, Madras . . .	9·5	36·7	9·3	44·5	1·7	0·4	1·6	44·3
XXVII	*Terminalia Chebula*, Retz. (Pedda Karaka.) From Nellore Division, Madras	10·2	45·9	16·2	27·7	2·3	2·1	6·2	27·7
XXVIII	*Terminalia pallida*, Brandis. (Budda Karaka.) From Nellore Division, Madras	8·9	39·0	13·3	38·8	2·3	1·3	4·5	38·3
XXIX	*Terminalia Chebula*, Retz. From Saharanpur Division, U.P.	10·9	33·8	20·4	24·9	2·1	1·9	8·7	25·2
XXX	*Terminalia Chebula*, Retz. From Dehra Dun Division, U.P.	9·1	40·9	24·7	25·3	2·5	2·7	9·2	25·0
XXXI	*Terminalia Chebula*, Retz. From Ramnagar Division, U.P.	9·9	44·5	25·8	19·8	2·2	1·7	6·0	19·8
XXXII	*Terminalia Chebula*, Retz. (Trees Nos. 2 and 6.) From Kangra Division, Punjab	9·4	36·0	18·3	36·3	2·1	1·6	5·2	36·1
XXXIII	*Terminalia Chebula*, Retz. (Trees Nos. 1 and 4.) From Kangra Division, Punjab	10·3	31·2	20·8	37·7	2·0	1·3	4·3	37·8
XXXIV	*Terminalia Chebula*, Retz. (From Tree No. 3, Dehra Dun.) From Forest Botanist's office, Dehra Dun, U.P. Fruit collected on 22/xi/21	9·7	38·2	28·9	23·2	2·4	1·2	4·2	23·1
XXXV	*Terminalia Chebula*, Retz. (From Tree No. 1, Dehra Dun.) From Forest Botanist's office, Dehra Dun, U.P. Fruit collected on 28/xi/21	10·1	38·7	22·1	29·1	2·4	0·9	3·7	29·1
XXXVI	*Terminalia Chebula*, Retz. (From Tree No. 3, Dehra Dun). Collected on 17/vii/21; from Forest Botanist's office, Dehra Dun, U.P.	7·5	45·8	20·7	26·0	2·5	3·3	16·7	25·3
XXXVII	*Terminalia Chebula*, Retz. (From Tree No. 1.) Collected on 17/vii/21; from Forest Botanist's office, Dehra Dun, U.P.	8·0	43·5	17·6	30·9	2·3	4·4	20·0	30·2

Results of Examination

The foregoing tables summarise the results of the examination of the samples at the Imperial Institute, Table A showing their colour, appearance, average length, diameter and weight, and Table B their composition. In order to facilitate comparison between the different samples, a column has been added to the latter table giving in each case the amount of tannin in the fruits containing 10 per cent. of moisture. This basis has been taken in preference to that of moisture-free material, as it more nearly represents the actual condition of myrobalans as marketed.

The myrobalans varied in shape from long, narrow fruits (some with bluntly pointed ends), as in the case of Sample No. 1, to small spherical fruits such as those of Sample No. 23. The samples were on the whole in good condition, but most of them showed slight signs of insect attack and Nos. 9, 36 and 37 were affected by mould.

Tanning Trials.—Trials were made to ascertain whether any marked variations were noticeable in the leathers yielded by different samples. For this purpose seven samples were selected, including all the four species of Terminalia represented. The results are shown in the table on p. 130.

The leathers produced by these seven samples all possessed the characteristic texture resulting from myrobalans tannages. No. 22, which deposited the most "bloom," furnished the thickest and heaviest leather, and was in these respects somewhat superior to the six other samples. The leathers yielded by Nos. 22, 25 and 18 were light-coloured; that from No. 37 was slightly darker; those furnished by Nos. 1 and 5 were still darker, and sample No. 6 gave the darkest leather.

It will thus be seen that the dark-coloured fruits Nos. 1, 5, 6 and 37 produced darker leathers than the paler fruits. It should be noted, however, that although No. 37 gave the highest tintometer reading of any of these four samples, it yielded paler leather than the other three. In the case of the light-coloured fruits the colour of the leather roughly corresponded to the tintometer readings.

The results of these small tanning trials thus tend

Sample.	Colour of myrobalans.	Results of examination.			Leather produced.	
		Extractive matter (non-tannin).	Tannin.	Tintometer readings.	Colour.	Texture, etc.
		Per cent.	*Per cent.*			
No. 1. *T. citrina* (probably), Assam.	Dark greyish to reddish-brown.	17·2	27·2	Red, 3·0 Yellow, 10·0	Fawn.	Fairly firm, not very plump, close texture.
No. 5. *T. tomentella*, Burma.	Dark greyish to reddish-brown.	17·6	19·5	Red, 2·8 Yellow, 11·5	Fawn.	Slightly more plump, but somewhat harsher than No. 1.
No. 6. *T. Chebula*, Burma.	Dark reddish-brown.	25·2	17·4	Red, 3·0 Yellow, 15·0	Medium brown.	Similar to No. 1, but slightly more plump.
No. 18. *T. pallida*, Madras.	Fairly light yellowish-brown, with greenish tinge.	12·3	37·8	Red, 0·9 Yellow, 2·6	Pale yellowish-buff.	Similar to No. 1.
No. 22. *T. Chebula*, Madras.	Fairly light yellowish-brown with greenish tinge.	9·3	48·9	Red, 0·5 Yellow, 1·9	Pale yellowish-buff, slightly lighter than No. 18.	Rather plump, firm.
No. 25. *T. Chebula*, Madras.	Yellowish-brown.	8·0	42·0	Red, 0·7 Yellow, 2·4	Pale yellowish-buff, slightly lighter than No. 22.	Similar to No. 1.
No. 37. *T. Chebula*, United Provinces.	Dark reddish-brown.	17·6	30·9	Red, 4·4 Yellow, 20·0	Fawn.	Similar to No. 5.

to indicate that differences in the colour of the leather produced are to be expected in general according to the colour of the fruits.

Remarks

The results of the analyses recorded in table B on pp. 127 and 128 show that these 37 samples of myrobalans vary widely in the amount of tannin present, the figures ranging from 12 to 49 per cent. in the fruits containing 10 per cent. of moisture. It is thus clear that the myrobalans differ considerably in quality.

The following observations may be made regarding the fruits of the different species represented.

T. Chebula.—The 29 samples differed widely in appearance, ranging from large, plump, almost globular

fruits, devoid of wrinkles, to small, elongated fruits, apparently well developed but much shrivelled and wrinkled.

The two samples from Burma (Nos. 6 and 7) contained the lowest amounts of tannin, viz. 17·3 and 12·0 per cent. respectively; the other 27 samples contained from 19·8 to 49·0 per cent. and most of them over 30 per cent. According to the *Indian Forest Bulletin*, No. 32 (1916), the identity of the so-called *T. Chebula* of Burma with the *T. Chebula* of Peninsular India is doubtful, as the fruits of the former were found to contain only about half the amount of tannin occurring in the latter. Kurz has regarded the Burma myrobalans as *T. tomentella*, which, however, is classified by Hooker as a variety of *T. Chebula*. The present results confirm the opinion that the Burma fruits contain a low percentage of tannin. In appearance the two samples (Nos. 6 and 7) from Burma are quite different from the samples of *T. Chebula* from India, but are identical with the two specimens (Nos. 4 and 5) of *T. tomentella* from Burma.

In the case of the other 27 samples of *T. Chebula* the highest amounts of tannin were found in the specimens from Madras, and of these the five samples from the Salem Division are of the greatest interest. These contained from 41·4 to 49·0 per cent. of tannin, the richest in tannin being No. 22 (described as "probably var. typica"). This sample had the lightest colour of all the myrobalans examined in the present investigation, and in this connection it was observed that in this series of 27 samples of *T. Chebula* the palest fruits contained the highest percentages of tannin. Only two other *T. Chebula* samples contained as much as 40 per cent. of tannin; these were also from Madras, viz. No. 14 from the West Vellore Division and No. 17 from Polur Range, South Vellore, which contained 42·1 and 40·6 per cent. of tannin respectively. In the 12 samples of *T. Chebula* from the Madras Presidency the tannin ranged from 25·9 to 49·0 per cent., seven samples containing over 40 per cent., and only 3 under 30 per cent. Commercial myrobalans usually contain from 30 to 40 per cent. of tannin, with an average of about 33 per cent., so that these fruits from the Madras

Presidency, and especially those from the Salem Division, are of particularly good quality.

Four samples of *T. Chebula* (Nos. 8, 9, 10 and 11) were received from the Central Provinces. These contained from 30·1 to 36·7 per cent. of tannin and would therefore be considered of good quality. No. 10, described as Harra No. 3 from Saonligarh Range in the Betul Division, contained the highest percentage of tannin.

The two samples from the Punjab (Nos. 32 and 33) contained 36·1 and 37·8 per cent. of tannin respectively; and the two from Bombay (Nos. 2 and 3), 31·3 and 35·9 per cent.

The remaining 7 samples of *T. Chebula* (Nos. 29–31 and 34–37), collected in the United Provinces, contained from 19·8 to 30·2 per cent. of tannin, so that, taken as a whole, they were the poorest in tannin of all the *T. Chebula* samples. They are characterised by high amounts of non-tannin extractive matter, viz. 17·6 to 28·9 per cent., as compared with 8·0 to 22·3 per cent. in the other 22 samples of *T. Chebula*.

Of these 7 samples from the United Provinces, four from Dehra Dun (Nos. 34 to 37) represented fruits collected at two different stages of maturity. The results of the examination of these four samples do not furnish sufficient data upon which to base any conclusions, though they indicate that the immature fruits may contain slightly more tannin.

T. pallida.—Only four samples of this species were received, viz. Nos. 12, 18, 20 and 28. The percentages of tannin in the fruits varied widely; No. 20 from South Cuddapah Division (described as "Tella Karaka") contained only 19·0 per cent. of tannin and No. 12 ("White Kadukai") from the Chingleput Division 28·3 per cent., whilst No. 18 ("White sp.") from the Chittoor Division contained 37·7 per cent., and No. 28 ("Budda Karaka") from the Nellore Division 38·3 per cent. The last two samples thus contained high percentages of tannin, equal to that in *T. Chebula* fruits of good quality, but not so high as the yield from the best *T. Chebula* fruits.

The four samples of *T. pallida* differed somewhat in appearance; No. 12 ("White Kadukai") contained

fruits of very varied types and appeared to be a mixed sample, whilst the fruits in the three other samples possessed the common characteristic of prominent ridges, especially No. 20 (" Tella Karaka ").

T. tomentella.—As already stated, this species is regarded by Hooker as a variety of *T. Chebula.* Two samples only (Nos. 4 and 5), collected in the South Pegu Division of Burma, were received under this description. They were dark-coloured fruits, distinct in appearance from those of *T. Chebula*, and yielded dark extracts. They contained low percentages of tannin, viz. 16·1 and 19·2. As previously mentioned, two of the samples (Nos. 6 and 7) from Burma described as " *T. Chebula* " were identical in appearance with these two samples of *T. tomentella* and also contained low amounts of tannin, viz. 17·3 and 12·0 per cent.

T. citrina (probably).—One sample (No. 1), collected in Assam, was forwarded under this description. The fruits were distinct in general appearance from all the other 36 samples examined. They were of dark colour, very hard and shrivelled, and had the smallest average diameter of all the fruits. They contained a fair amount of tannin, viz. 26·2 per cent.

Terminalia sp.—This sample (No. 13) was described as " Black Kadukai " from the Chingleput division of Madras, and contained a fair quantity of tannin, viz. 26·9 per cent.

Conclusions

From the results of this investigation it is clear that the fruits of *Terminalia Chebula* from different districts of India may vary widely in quality, the amounts of tannin present in these samples ranging from about 20 to 49 per cent. in fruits containing 10 per cent. of moisture.

In view of these marked differences and the fact that the highest percentages of tannin found are much above those recorded for commercial myrobalans, it would appear desirable to determine the varieties of *T. Chebula* represented by the specimens in order to ascertain whether these varieties can be correlated with the amounts of tannin in the fruits. The question whether the differences depend

to any degree on the locality in which the trees grow or on other climatic causes might also be considered.

After the botanical varieties of *T. Chebula* have been determined in India, it would be of interest to receive representative samples of the fruits of each variety from various localities for further investigation. The fruits from Madras, and particularly those from the Salem Division which contained the highest percentages of tannin, are worth special investigation, as it may be possible to obtain a superior quality of myrobalans from these districts.

Only a few samples of the fruits of species of Terminalia other than *T. Chebula* were included in the collection, and no definite conclusions can be drawn as to their relative values. It would be desirable to examine further samples of the fruits of these Terminalias with a view to establishing their average quality and commercial value.

Further samples of mature and immature fruits from the same tree will also have to be examined in order to decide the stage at which the largest amount of tannin is present.

DATURA METEL FROM MONTSERRAT

FOUR samples of *Datura Metel* were forwarded to the Imperial Institute by the Curator of the Botanic Station, Montserrat, for examination in September, 1922.

It was stated that the samples were obtained in trials carried out at the Experiment Station. They were as follows :

No. 1. *Stems and leaves from undeflowered rows.*—This consisted of stems and leaves in good condition. The stems were in pieces up to 6 in. long and of pale brownish-yellow tint; the leaves were brownish-green, dry and crumpled, and much broken leaf was present. A few small unripe fruits were included in the sample.

No. 2. *Growth from deflowered rows, not bearing fruits.*—This was similar to sample No. 1, but no fruits were present.

No. 3. *Leaves of plant only.*—This consisted of leaves and leaf-stalks similar to those in samples Nos. 1 and 2.

No. 4. *Stems of plant only.*—This material consisted of stems similar to those in samples Nos. 1 and 2.

The amounts and nature of the alkaloids present in each of the samples were determined with the following results :—

	No. 1. Stems and leaves from undeflowered rows. Per cent.	No. 2. Stems and leaves from deflowered rows. Per cent.	No. 3. Leaves only. Per cent.	No. 4. Stems only. Per cent.
Moisture	10·0	9·1	9·6	10·1
Total alkaloids in material as received	0·22	0·33	0·35	0·29
Total alkaloids expressed on moisture-free material	0·24	0·36	0·39	0·32
Nature of the alkaloids present	Approximately one part of scopolamine to four parts of hyoscyamine.	Mainly or entirely scopolamine.	Mainly or entirely scopolamine.	Mainly or entirely scopolamine.

The results show that the amount of alkaloids present in sample No. 2 was much greater than in No. 1 and it seems possible that this may be due to the deflowering of the plants. Moreover it will be observed that the plants which were allowed to bear fruits (Sample No. 1) yielded alkaloid which was mainly hyoscyamine, whereas the alkaloid in the deflowered plants (No. 2) was mainly, if not wholly, scopolamine. These results are of interest as suggesting that by means of deflowering *D. Metel* might be improved as a source of scopolamine.

The amount of alkaloid in sample No. 1 is rather low, whilst that in No. 2 is fairly good. A sample of *D. Metel* stems and leaves from Montserrat examined at the Imperial Institute in 1917 contained 0·42 per cent. of total alkaloid, expressed on the moisture-free material. There are no recorded figures for the alkaloid in *D. Metel* stalks, but the leaves have been stated to contain from 0·25 to 0·55 per cent. of alkaloid, usually consisting of scopolamine with occasionally a little hyoscyamine or atropine.

It was not stated whether samples Nos. 3 and 4 were derived from undeflowered or deflowered plants, but (judging from Nos. 1 and 2) the results obtained would

suggest the latter. From the amount and nature of the alkaloid present there would appear to be no advantage in separating the plants into leaves and stems for commercial purposes since, in the present case, both portions contained about the same amount of alkaloid, consisting almost entirely of scopolamine.

It may be mentioned that the removal of the flower buds from plants of eight different species of *Datura* (not including *D. Metel*) was found by A. F. Sievers (*Journ. Amer. Pharm. Soc.*, 1921, **10**, 674) to produce a great increase in the amount of alkaloid, the average yield being raised from 0·4 to 1·3 per cent.

PRESERVATION OF RUBBER LATEX BY AMMONIA

In connection with the Ceylon Rubber Research Scheme two series of samples have recently been examined at the Imperial Institute. The first series consisted of ten samples of rubber latex preserved by ammonia, which were examined principally to determine (1) the quantity of ammonia which estates should be advised to use for the preservation of latex, and (2) the suitability of iron drums for use as containers for latex shipped to Europe. The second series comprised three samples of crêpe rubber which had been prepared to determine whether the addition of ammonia to latex had any effect on the vulcanising and mechanical properties of the rubber.

Series I

The ten samples of rubber latex in this Series were prepared by the Chemist in Ceylon on Culloden Estate (Old Division, Group 3). It was stated that the samples probably represented average latex as the trees from which it was derived were from 10 to 25 years old, growing on the hillside and on flat land.

The following are the details relating to the preparation of the samples and the results of their preliminary examination at the Imperial Institute. Samples 1A to 5A inclu-

five were sent from Ceylon in kerosene tins and samples 10A to 14A in iron drums.

Sample number.	Date of preparation.	Volume of latex.	Rubber in preserved latex.	Ammonia.[1]			Acetic acid required for complete coagulation at Imp. Inst.[3]
				Added in Ceylon.	Found at the Imp. Inst.[2]	Difference.	
		Galls.	Per cent.	Per cent.	Per cent.		Per cent.
1A .	4.1.23	3½	33·2	0·89	0·82	0·07	7·3
2A .	4.1.23	3½	33·0	1·19	1·00	0·19	8·0
3A .	5.1.23	3½	32·5	1·80	1·57	0·23	14·3
4A .	5.1.23	3½	31·8	2·40	2·17	0·23	19·9
5A .	8.1.23	3	32·6	2·92	2·73	0·19	25·4
10A .	4.1.23	4½	33.2	0·89	0·78	0·11	5·9
11A .	4.1.23	4½	33·0	1·19	1·06	0·13	9·2
12A .	4.1.23	4½	32·5	1·80	1·63	0·17	16·3
13A .	5.1.23	4½	31·8	2·40	2·27	0·13	23·3
14A .	8.1.23	4	32·6	2·92	2·55	0·37	25·5

[1] *Calculated as dry ammonia on the dry rubber.*

[2] *By steam distillation and titration of the distillate with standard sulphuric acid.*

[3] *Calculated as dry acetic acid on dry rubber.*

(1) *Containers.*—The kerosene tins had been damaged during transit, and at least one had commenced to leak at the seams. These leaks caused no serious loss of latex as they soon became sealed with a film of rubber. The iron drums arrived in good condition.

(2) *Preliminary inspection.*—None of the samples of latex had coagulated except for a little coagulum generally found attached to the part where the containing vessel had been sealed. In every case the latex had "creamed" and there was a little dark-coloured deposit at the bottom of each container. The results of examination of this deposit are dealt with later (p. 139). Samples 1A and 10A (containing the least quantity of ammonia) had a very unpleasant odour, doubtless due to putrefaction.

(3) *Microscopic examination.*—The latex was examined at a dilution of 1 in 100. In each sample a flocculation of globules could be observed, ranging from two to three globules per group in the case of samples containing the largest quantity of ammonia to 20 to 30 globules per group in the case of samples containing the smallest quantity of ammonia. The flocculation was not general, but occurred in isolated patches.

No appreciable difference was found between the latex in the kerosene tins and that in the iron drums.

Since special care was taken both in Ceylon and London to avoid loss of ammonia, the small differences between the quantities added in Ceylon and those found when the samples were examined at the Imperial Institute, four months later, may be largely due to the ammonia reacting with some of the non-rubber constituents of the latex.

In the case of each sample, the amount of acetic acid required for *complete* coagulation was far in excess of that required to coagulate the same quantity of fresh latex and to neutralise the ammonia present, and was roughly proportional to the amount of ammonia used for preservation.

Mechanical and Vulcanising Tests

The results of the mechanical and vulcanising tests on the rubber prepared from the latex at the Imperial Institute are summarised in the following table. The coagulum was converted into thin crêpe and dried in the air at ordinary temperature.

Latex No.	Time of cure	Tensile strength	Elongation.		Slope.
			At break.	At load of 1·04 kg/sq mm.	
	Mins	*lb/sq. in*	*Per cent.*	*Per cent.*	
1A	115	2,340	855	777	35
2A	130	2,240	859	781	36
3A	126	2,050	842	786	37
4A	125	2,090	840	771	36
5A	125	2,330	874	784	36
10A	110	2,170	853	786	36
11A	115	1,970	832	778	36
12A	120	2,200	849	775	37
13A	115	2,370	854	774	36
14A	115	2,180	851	787	36

The results show that in the case of these samples there is no correlation between the amount of ammonia added to the latex and the mechanical properties of the vulcanised rubber, nor is there any appreciable difference between the properties of the rubbers prepared from latices shipped in kerosene tins and in iron drums.

The rate of vulcanisation of the samples is fairly constant and in agreement with the results previously obtained at the Imperial Institute with crêpe rubber prepared in

Ceylon from fresh latex to which no ammonia had been added. The tensile strengths are irregular and somewhat below the average for crêpe rubber; there is, however, no definite evidence of deterioration of the rubber due to the presence of ammonia in the latex, especially as the slope of the stress-strain curves remains fairly low.

Nature of the Deposit

A detailed examination was made of the deposits from samples Nos. 3A and 5A. The deposits, which amounted to about 4 ozs. in each case, consisted of dark-coloured material which could be stretched when dry, but was only slightly elastic and broke easily.

The dry deposit, which contained about 30 per cent. of rubber, was submitted to chemical examination with the results shown in the following table, which are expressed as percentages of the dry deposit.

		Deposit from Latex No. 3A (preserved with 1·80 per cent. of ammonia).[1]	Deposit from Latex No. 5A (preserved with 2·92 per cent. of ammonia).[1]
		Per cent.	*Per cent.*
Acetone extract		11·6	6·4
Nitrogenous matter insoluble in acetone[2]	N	2·4	1·6
Ferric oxide	Fe_2O_3	9·0	15·1
Magnesium oxide	MgO	16·0	13·1
Phosphoric anhydride	P_2O_5	28·0	23·6

[1] *Calculated as dry ammonia on the dry rubber.*

[2] *About* 30 *per cent. of the nitrogenous matter present was volatile in steam in the presence of magnesium oxide.*

Traces of compounds of potassium, silica, and tin were found in the deposits.

The results show that the deposit consists chiefly of mineral matter in which magnesium, iron, and phosphoric acid predominate. Acetone-soluble substances and derivatives of protein and ammonia are also present in addition to rubber, and it is possible that the phosphoric anhydride and magnesium oxide, which are in equimolecular proportions form part of a complex organic compound.

Dr. de Vries states that in Java he has found magnesium ammonium phosphate in similar deposits. In the deposits from the Ceylon latex, however, only a small quantity of the nitrogen occurred as ammonia, and the bulk of the

magnesium oxide and phosphoric anhydride must therefore have been present in some other form than magnesium ammonium phosphate.

The iron and tin in the deposit may have been derived from the tin containers.

Series II

The three samples of crêpe rubber, prepared to determine whether the addition of ammonia to latex had any effect on the vulcanising and mechanical properties of the rubber, were as follows :—

No. 32.—Prepared on August 30, 1923, on Culloden Estate from fresh latex with approximately twice the amount of acetic acid normally used.

No. 34.—Prepared on August 30, 1923, on Culloden Estate from a portion of the same latex as Sample No. 32, but 3·75 per cent. of 20 per cent. ammonia added before coagulation with excess of acetic acid. The diluted latex thus contained 3·62 per cent. of 20 per cent. ammonia.

No. 30.—Prepared from a portion of the same latex as Sample No. 34, containing the same amount of ammonia, and coagulated at the Imperial Institute with excess of acetic acid three months after the addition of the ammonia.

The latex from which sample No. 30 was prepared was in a good state of preservation when examined at the Imperial Institute. Prior to coagulation it was well shaken and its alkalinity determined. This was found to correspond to 3·65 per cent. of 20 per cent. ammonia as compared with 3·62 per cent. calculated on the amount of ammonia added in Ceylon.

The results of mechanical and vulcanising tests in a rubber-sulphur mixing were as follows :—

	Standard cure.					Tensile optimum cure.		
	Time of cure.	Tensile strength.	Elongation. At break.	Elongation. At standard load.	Slope.	Time of cure.	Tensile strength.	Elongation at standard load.
	Mins.	*lb./sq. in.*	*Per cent.*	*Per cent.*		*Mins.*	*lb./sq. in.*	*Per cent.*
No. 32	130	2,340	876	797	39	130	2,340	797
No. 34	150	1,990	837	790	36	140	2,250	817
No. 30	120	2,170	829	780	40	120	2,170	780

It will be seen that there are small differences in the time of cure of these rubbers, and that No. 34, in which ammonia was added shortly before coagulation, cured more slowly than sample No. 30 prepared three months later from another portion of the latex containing the same amount of ammonia. The two rubbers prepared from latex containing ammonia are not quite as strong as that prepared from fresh latex, but the differences are not marked.

These experiments confirm the results obtained with the series of crêpe rubbers dealt with above (p. 138), but in the latter case no control sample was available and no direct comparison could therefore be made.

HOPKINSON SPRAYED LATEX RUBBER

In view of the interest attaching to rubber prepared by the Hopkinson process (U.K. Patent 157,975, 1922) several samples of this rubber have been examined at the Imperial Institute in connection with the investigations carried out under the Ceylon Rubber Research Scheme. In this process latex preserved with ammonia is conveyed to a tank, where it is agitated and delivered at a uniform rate to an air jet, which sprays the latex as a stream of finely divided particles into a chamber. Here the particles meet a second stream of air heated to approximately 200° F. Under these conditions the latex dries very quickly. The dried particles are thrown by centrifugal action on to the walls of the chamber.

The product is white and spongy and may be readily broken with the fingers. It is usually pressed into blocks, after which it has the characteristic properties of ordinary raw rubber.

As rubber prepared in this way contains all the solid constituents of the latex, the total yield is approximately 10 per cent. greater than when the latex is coagulated with acetic acid. It is claimed by the patentee that when the rubber is compounded with sulphur the vulcanised product has a tensile strength and resistance to abrasion 20 per

cent. greater than that of rubber coagulated with acetic acid. When the compounding ingredients are sprayed with the latex the improvement is stated to be still greater.

The samples examined were as follows :

Sample No.	Label.	Supplied by
1.	Regular L.S.	Rubber Growers' Association, April 1923.
2.	Regular L.S. "Primed and Brominated."	Rubber Growers' Association, April 1923.
3.	Regular L.S. "Primed and Brominated." (from same consignment) as Sample No. 2).	Rubber Growers' Association, October 1923.
4.	—	The Dunlop Rubber Co., Ltd, August 1923.
5.	—	Consulting Chemist, Rubber Growers' Association, October 1923.

It was stated by the Rubber Growers' Association that Sample No. 1 had been forwarded to London packed in a case and that No. 2 was sent without any packing.

The samples consisted of blocks of dark yellowish-brown rubber of mottled appearance due to the intermingling of light and dark-coloured portions. Occasional small lumps of mineral matter, about the size of a pea, were present in samples Nos. 1 and 2.

Vulcanising and mechanical tests were carried out on these samples with the standard rubber-sulphur mixing (90 : 10), and with different types of zinc oxide mixings, the curing being effected under hydraulic pressure in steel moulds in an autoclave at 148° C. (= 51½ lb./sq. in. steam pressure). The rubbers required more mastication than ordinary sheet or crêpe rubber, and caused the powders to cake on the mixing rolls.

A. Rubber-Sulphur Mixing (90 : 10)

The results of the tests are shown in the following table in comparison with the average results obtained with samples of smoked sheet and crêpe rubber.

TABLE NO. 1

Standard Cure

(Elongation at load of 1·04 kgs./sq. mm. = 775 per cent.)

Sample No.	Time of cure.	Tensile strength.	Elongation. At break.	Elongation. At load of 1·04 kgs./sq mm	Slope.	Vulcanisation coefficient.
Hopkinson rubbers :	*Mins.*	*lb /sq in*	*Per cent*	*Per cent*		
1	60	2060	837	773	38	4·76
2	60	2200	869	791	37	4·29
3	60	2240	871	794	40	—
4	57	2220	851	776	38	4·58
4 (washed) .	60	2540	879	778	40	—
5	60	2190	880	797	39	—
Plantation rubbers :						
Thin crêpe (average of five recent samples) . .	136	2210	854	781	37	—
Smoked sheet (average of five recent samples) .	107	2440	867	777	40	—

TABLE NO. 2

Sample No.	Range of cures over which tensile strength exceeds 2,000 lb /sq in.	Vulcanisation coefficient range.	Maximum tensile strength.[1]
Hopkinson rubbers :	*Mins.*		*lb./sq. in.*
1	45–70	3·6–5·6	2340
2	50–70	3·5–5·0	2440
4	40–65	3·2–5·2	2230

[1] *The average maximum tensile strength of a number of samples of different forms of plantation rubber recently examined under the same conditions is about* 2,450 *lb./sq. in.*

The results in Table No. 1 show that in this rubber-sulphur mixing the samples of Hopkinson rubber vulcanise much more quickly than either the smoked sheet or crêpe rubbers. Moreover, they are remarkably uniform in time of cure, having an average variation of about 1 per cent. as compared with a variation of 6 per cent. in the case of the plantation rubbers referred to in the table. It would, however, be necessary to examine many more samples of Hopkinson rubber before drawing any definite conclusions regarding their variability.

It will also be seen from Table No. 1 that the washing of sample No. 4, involving a loss in weight of only 0·5

per cent., effected a marked improvement in tensile strength.

In a rubber-sulphur mixing the Hopkinson rubbers give a good tensile strength over a wide range of cures (see Table No. 2), and this property is stated to be of value in certain manufacturing operations. Preliminary investigations indicate that plantation rubbers do not, in all cases, have such a wide range of cures giving a good tensile strength.

The maximum tensile strength of these Hopkinson samples is slightly below that of plantation sheet (smoked) and crêpe.

B. Accelerator Mixing

The results obtained in the standard accelerator mixing used at the Imperial Institute, viz. 90 rubber, 90 zinc oxide, 5 sulphur, 1 hexamine (hexamethylenetetramine), are shown in the following table.

TABLE No 3

	Standard Cure (Elongation at load of 1 04 kgs / sq mm = 480 per cent)				*Tensile Optimum Cure* (Maximum tensile strength developed 72 hours after vulcanisation)			Vulcanisation coefficient
Sample No	Time of cure	Tensile strength	Elongation At break	Elongation At load of 1 04 kgs / sq mm	Time of cure	Tensile strength	Elongation at load of 1 04 kgs / sq mm	At 40 mins cure
Hopkinson rubbers	*Mins*	*lb /sq in*	*Per cent*	*Per cent*	*Mins*	*lb /sq in*	*Per cent*	
1	25	2100	601	489	40	2830	403	2 64
2	25	2140	589	480	50	2620	378	2 52
4	20	2290	630	494	50	2760	395	2 88
Thin crêpe (average of five recent samples)	42	2610	624	486	45	2660	478	2 21
Smoked sheet (average of five recent samples)	37	2490	604	481	45	2760	458	1·97

The results show that in this mixing the Hopkinson rubbers had a maximum tensile strength equal to that of the

plantation rubbers, and that both required about the same time of cure to reach their maximum tensile strength. The Hopkinson rubbers stretched much less than the plantation rubbers, and had a higher vulcanisation coefficient when cured for the same time.

C. Zinc Oxide Mixing

In view of the high tensile strength claimed for Hopkinson rubbers in rubber : zinc oxide : sulphur mixings, samples Nos. 1 and 2 were examined in the mixing 90 rubber, 90 zinc oxide, 10 sulphur. The results at 30 minutes' (approximately standard[1]) cure were as follows :

TABLE NO. 4

Sample No.	Tensile strength.	Elongation at break.	Elongation at a load of 1·04 kgs./sq. mm.
	lb./sq. in.	*Per cent.*	*Per cent.*
1	2260	618	491
2	2070	617	503

In the case of three samples of smoked sheet tested recently under the same conditions, the addition of zinc oxide to the rubber-sulphur mixing prolonged their time of cure and reduced their tensile strength. On the other hand, a comparison of the results given in the above table (No. 4) with those in Table No. 1 shows that the addition of zinc oxide considerably shortened the time of cure and did not appreciably reduce the tensile strength of the Hopkinson rubbers.

D. Other Tests

(1) *Colour Differences*

The lightest and darkest coloured portions of sample No. 2 were separated in order that tests might be made to determine whether they differed in chemical composition or vulcanising properties.

The two portions were submitted to chemical examination with the results shown in the following table :

[1] *Elongation at a load of 1·04 kgs./sq. mm. = 480 per cent.*

TABLE No. 5

	Test No. 1.		Test No. 2.	
	Dark.	Light.	Dark.	Light.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	1·1	1·4	—	—
Acetone extract	4·1	4·4	3·2	3·5
Nitrogen soluble in acetone .	0·029	0·038	0·027	0·200
Insoluble in acetone but soluble in water	3·0	3·8	2·5	3·4
Acid value[1]	3·3	1·3	3·3	3·2
Saponification value[1] . .	3·0	1·4	—	—

[1] *Determined on the acetone extract; the percentage is expressed on the rubber.*

Both tests showed a small variation in the chemical composition of the light and dark-coloured portions of the rubber. The results of Test No 1 indicated that there was a distinct difference between the two portions in the acid values of the acetone-soluble constituents, but this was not confirmed by Test No. 2.

The results of vulcanising and mechanical tests with a rubber-sulphur and with an accelerator mixing are given below (Table No. 6). In view of the different acid values of the acetone extract recorded in Test No. 1, an accelerator mixing in which certain organic acids are known to have a large effect on the elongations at standard load was substituted for the accelerator mixing generally employed.

TABLE No. 6

Mixing.	Rubber : sulphur. 90 : 10.		90 rubber, 5 sulphur, 5 zinc oxide, 1 hexamine.	
	Light.	*Dark.*	*Light.*	*Dark.*
Time of cure . . . *mins.*	60	60	40	40
Tensile strength . *lb./sq. in.*	2250	2230	2940	2470
Elongation at break *per cent.*	853	848	727	696
Elongation at load of 1·04 kgs./sq. mm. . . *per cent.*	774	787	597	599
Slope	39	38	34	35

It will be seen that with this accelerator mixing there was no appreciable difference between the light and dark-coloured portions in the elongations at the standard load. The light-coloured portion was stronger than the dark portion and this was confirmed by a repeat test.

In the rubber-sulphur mixing the difference between the two portions in tensile strength and in elongation at standard load was very small.

(2) *Vulcanising Tests in Open Steam*

As Hopkinson rubbers contain nearly 10 per cent. of water-soluble ingredients, some of which are hygroscopic, curing in open steam may be expected to give different results from curing in steel moulds under hydraulic pressure (the method ordinarily used at the Imperial Institute).

A rubber-sulphur mixing (90 : 10) of sample No. 1 was wrapped with cloth on an iron mandrel and vulcanised for 60 minutes (time of standard cure) in open steam. The vulcanised product was extremely weak (about 100 lb./sq. in.) in spite of the fact that the initial portion of the stress-strain curve indicated that the relation between load and elongation was similar to that obtained when the rubber was vulcanised for the same length of time in an autoclave; in the latter case the rubber had a tensile strength of 2,060 lb./sq. in. (see Table No. 1). A sample of sheet rubber vulcanised in open steam under the same conditions had a tensile strength of 1,500 lb./sq. in. at the standard cure. These results indicate that Hopkinson rubber can be cured to a greater extent in a closed mould than in open steam without becoming brittle within a few days of cure.

It was found that, thirty minutes after completion of cure, the Hopkinson rubbers had absorbed over 4·0 per cent. of moisture, whereas a series of plantation rubbers had absorbed 0·5 to 1·0 per cent. Moreover, on exposure to steam under pressure for 60 minutes and then drying, the unvulcanised Hopkinson rubber lost 1·6 per cent. in weight, whereas a sample of crêpe rubber lost only 0·3 per cent.

Preliminary experiments indicate that by soaking vulcanised Hopkinson rubber in water a remarkable improvement in tensile strength is obtained. It is evident that the effect of the water-soluble and hygroscopic constituents in this rubber requires further investigation.

(3) *Artificial "Ageing" Tests*

Sample No. 1 was cured to give a vulcanisation coefficient of 3·0 and then artificially aged for six hours at 70° C. The effect of this "ageing" was to decrease the elongation from 850 to 790 per cent., which compares favourably with the decrease in elongation which occurred in the case of a few forms of plantation rubber recently "aged" under similar conditions.

SUMMARY

The results of this investigation show that:

(1) The samples of Hopkinson sprayed latex rubber possess unusual features but do not appear to be generally superior to plantation rubber.

(2) They require a longer time of mastication than plantation sheet or crêpe, and they cause powders to cake on the mixing rolls.

(3) Their vulcanising and mechanical properties in a rubber-sulphur mixing (90 : 10) are remarkably uniform; they all vulcanise quickly and have a moderate tensile strength over a wide range of cures, but their maximum tensile strength does not exceed the average of either sheet or crêpe rubber. There are indications that they may "age" fairly well in this mixing.

(4) In the mixing 90 rubber, 10 sulphur and 90 zinc oxide, the time of cure is reduced as compared with that in the rubber-sulphur mixing (90 : 10) and the maximum tensile strength is not appreciably altered, whereas in the case of samples of plantation rubber the addition of zinc oxide to the rubber-sulphur mixing increased the time of cure and decreased the tensile strength.

(5) In the mixing 90 rubber, 5 sulphur, 90 zinc oxide and 1 hexamine the Hopkinson rubbers have a maximum tensile strength equal to that of plantation rubbers and combine with sulphur somewhat more quickly than the latter.

(6) There is no important difference in the composition of the light and dark-coloured portions or in the properties of the vulcanised products in a rubber-sulphur mixing.

In the mixing 90 rubber, 5 sulphur, 5 zinc oxide and 1 hexamine the light-coloured portion is much stronger.

(7) The sample forwarded without packing does not appear to be inferior to the others in vulcanising and mechanical properties.

(8) Both steam and water have a marked effect on the properties of Hopkinson rubbers.

REPORT BY THE IMPERIAL INSTITUTE COMMITTEE ON TIMBERS

EMPIRE TIMBERS FOR MOTOR BODIES

In the statement regarding the work of the Imperial Institute Advisory Committee on Timbers, published in this Bulletin (1923, **20**, 88), reference was made to practical trials which were being carried out under the auspices of the Committee with a view to testing the suitability of selected Empire timbers for motor-body building in place of foreign woods which are largely used for this purpose. The trials have now been concluded, and, in view of the satisfactory results obtained, the following account of the investigation will be of interest.

In November, 1920, at the suggestion of Mr. Percy Preston (a member of the Timbers Committee) a deputation from the Institute of British Carriage and Automobile Manufacturers visited the Imperial Institute and inspected a number of promising Empire timbers with a view to selecting those which appeared to be worth trial for the construction of motor bodies in the place of foreign woods.

The deputation made a preliminary selection of timbers from Nigeria, British Guiana, and British North Borneo, and also considered certain Indian woods which had been exhibited at the Empire Timber Exhibition held at Holland Park during the previous summer. The timbers finally selected comprised Sapele mahogany and Iroko from Nigeria, Crabwood from British Guiana, and Gurjun, White Bombwe, White Mahogany and White Chuglam from India.

Mr. Lawton Goodman (who was later nominated to the Timbers Committee by the Institute of British Car-

riage and Automobile Manufacturers) undertook to carry out practical trials with the selected woods in the workshops of Messrs. Whitlock-Motors, Ltd. A quantity of the first three timbers was supplied for the tests by the Imperial Institute, the Indian woods being obtained by Messrs. Whitlock Motors, Ltd., from Messrs. W. W. Howard Bros. & Co.

The following are brief notes on the timbers selected:

Sapele Mahogany (*Entandrophragma* sp.).—A well-known Nigerian mahogany which hitherto has been more widely used on the Continent than in this country. It possesses the attractive banding met with in certain mahoganies and, when cut on the quarter, does not warp or twist. The working and polishing qualities are excellent.

Iroko (*Chlorophora excelsa*).—This wood, also known as West African teak, is familiar to the trade in this country. It is a strong timber, and in general appearance resembles Indian teak though not possessing the characteristic "oil" of that timber. It is highly valued in West Africa for construction work, building, furniture and many other purposes, and should be more widely used in this country.

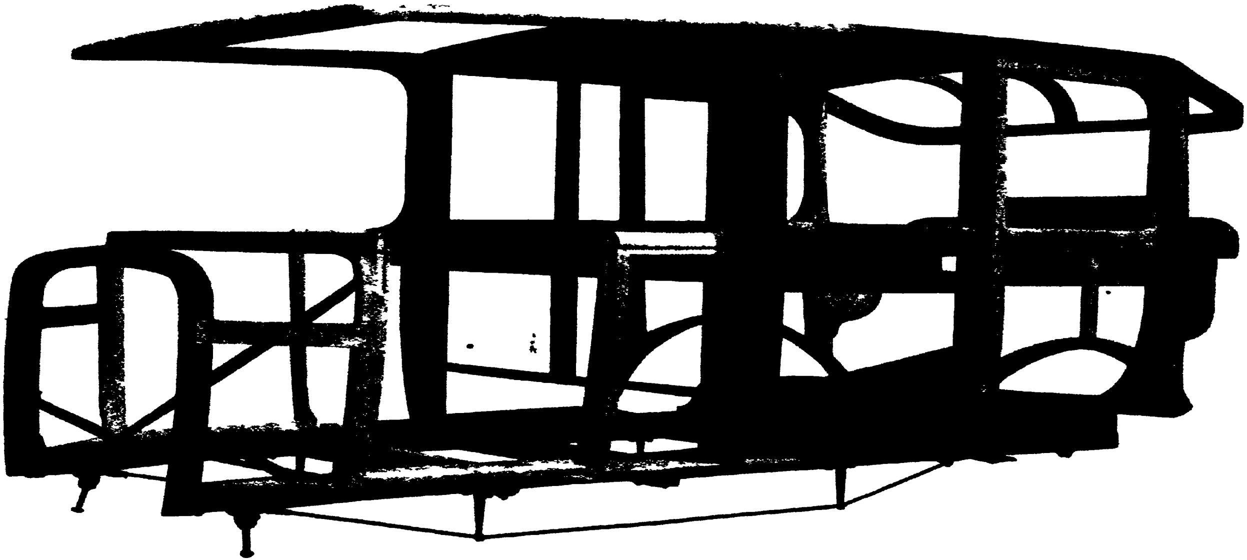
Crabwood (*Carapa guianensis*).—This is one of the most useful woods of British Guiana where it is much used for furniture, cabinet work and building purposes. The tree belongs to the mahogany family, and in general characters the wood resembles medium qualities of mahogany for which it is suitable as a substitute. Crabwood has been successfully used in the British Guiana Court at the Imperial Institute for the construction of show cases and an ornamental screen.

Gurjun (*Dipterocarpus turbinatus*).—One of the most useful and promising of the Indian timbers marketed in this country during recent years. It is pale, greyish-brown, moderately hard and heavy, oily to the touch and has good working qualities.

White Bombwe (*Terminalia Catappa*).—A fine, pale yellowish-brown timber of light to moderate weight, medium hardness, and close-grained.

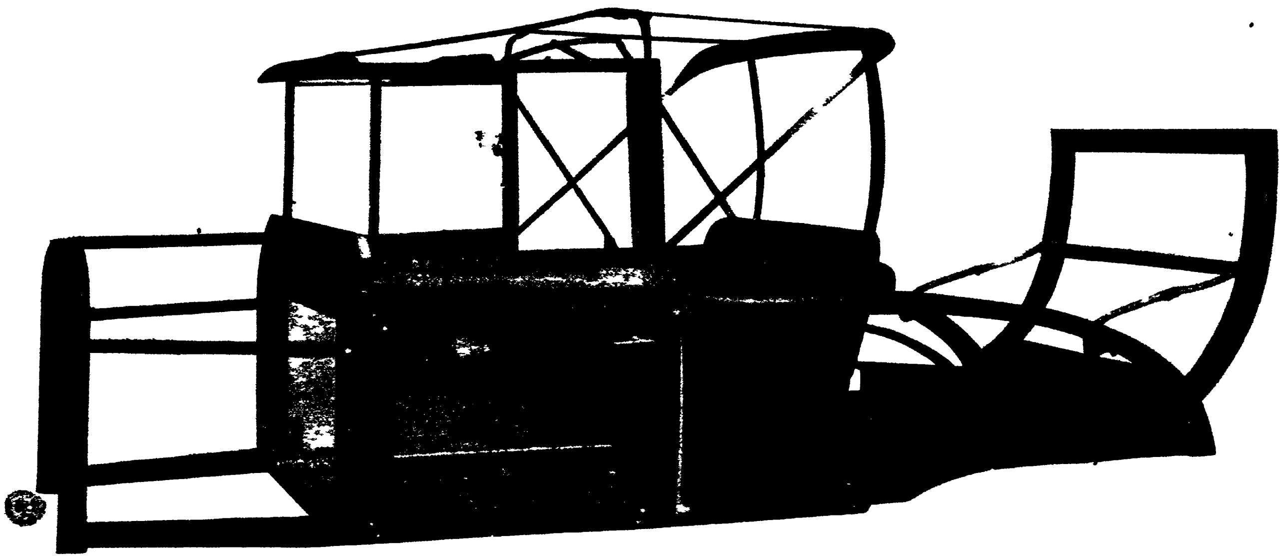
Indian White Mahogany (? *Canarium* sp.).—An excellent, smooth, finely-grained wood, with easy working qualities and good appearance.

PLATE I.—FOUR-DOOR LANDAULETTE BODY MANUFACTURED EXCLUSIVELY OF INDIAN WOODS BY MESSRS WHITLOCK MOTORS LTD.



The door frames, door posts and bottom sides are of Teak, other woods used are White Bombwe, White Chuglam, and Indian White Mahogany

PLATE II.—COUPÉ BODY, MANUFACTURED EXCLUSIVELY OF EMPIRE WOODS BY MESSRS WHITLOCK MOTORS LTD



The woods employed are bottom sides Iroko frame work Sapele Mahogany front pillars Gurjun bottom boards, Crabwood

White Chuglam.—An attractive, yellowish-grey wood with a smooth, wavy grain and pleasing lustre. The weight and hardness are moderate, and the working qualities good.

The trials at the Whitlock works extended over a prolonged period and recently an account of the results was furnished by Mr. Goodman as a report to the Council of the Institute of British Carriage and Automobile Manufacturers, the report being subsequently communicated to the Imperial Institute Timbers Committee.

Mr. Goodman states that his firm constructed two bodies for the tests (see Plates I and II). The first was a four-door landaulette built of wood and aluminium and fitted to a Daimler chassis. The timbers used for this body comprised, exclusively, the following Indian timbers: White Bombwe, White Mahogany and White Chuglam; the polished decorative woodwork of the interior of the car was of Indian burr walnut and the mouldings of Indian laurel. The works report was to the effect that these timbers machined well, being similar to certain mahoganies in their general working qualities. The weights came out at much about the same as English ash, and there was a great saving in marking out as the planks were free from knots and were supplied square-edged in good lengths of various thicknesses. There was a great saving as regards wastage, and the painting and finishing qualities were very satisfactory. The prices of the timbers at the time varied from 6*s*. per foot cube, in the case of White Bombwe, to 7*s*. in the case of Gurjun and 9*s*. in the case of teak.

The second body constructed was a two-seater "all weather" model fitted to a Whitlock chassis and built of British Guiana Crabwood, Nigerian Iroko and Sapele Mahogany, and Indian Gurjun. With one exception all these woods machined well and were satisfactory, the Sapele and Crabwood being very similar in character to the ordinary grades of mahogany at present used in motor-body work. The Gurjun was particularly satisfactory, but the planks of Iroko when opened up were faulty; it is hoped to conduct further trials with this useful and promising wood for which, as is well known, there is already a good market in this country.

Mr. Goodman, in his report, expresses entire satisfac-

tion with the Empire timbers used by him in the trials, which he considers have demonstrated the practical utility of these woods as substitutes for foreign timbers for body work, and he commends the use of Empire timbers to the motor-body industry in general. He lays particular stress upon the fine qualities of the Indian timbers used and their suitability for the industry. As a result of the trials Messrs. Whitlock Motors, Ltd., have adopted Indian White Mahogany, White Chuglam, White Bombwe, and Burma teak as standard timbers for the construction of their motor-bodies.

ARTICLES

SILK PRODUCTION IN THE EMPIRE[1]

By H. Maxwell-Lefroy, M.A.

Professor of Entomology, Imperial College of Science and Technology, and Member of the Advisory Committee on Silk Production of the Imperial Institute.

Silk is not now one of the important products of the Empire; the silk that is the raw material used in the preparing, spinning, and weaving factories in England, that is worn in all parts of the Empire, is, with the exception of part of India's consumption, produced in other countries. In 1913, out of 969,000 lb. of raw silk consumed in manufacture in England, only 25,000 lb. was from Empire sources; in 1922, out of 976,000 lb. (worth nearly £2,000,000), 78,000 lb. was from Empire sources. There is a very small export of raw silk or cocoons, while there is an enormous import of finished silk goods, as well as of raw material, such as waste silk and raw silk. It is a curious thing that with such large tropical and sub-tropical areas, there should be so little silk production; and it is an unsatisfactory condition that a product absolutely indispensable in certain war uses should be almost unobtainable from within our borders. This condition is not going to remain; silk is being produced

[1] A paper presented on June 12, 1924, at the Empire Textile Conference, organised by the Textile Institute and held at the British Empire Exhibition, Wembley. Reprinted by kind permission of the Editor of the *Journal of the Textile Institute*.

experimentally, and in a few years silk will be an important production.

I have a difficult task to-day; it is an ungrateful subject to deal with the production of a material in which the Empire is as yet so little interested. The Silk Production Committee of the Imperial Institute have been steadily working for eight years to help on silk production, and they believe that we have an opportunity in the British Empire Exhibition to further the development which is being tried out in all parts of the Empire. So I propose to discuss this on broad lines, without too much technical matter, and without statistics, but trying to put before you the present position and the factors that will make for success. As silk production is not familiar to everyone, I have also introduced the salient points in the production of silk.

Producing Areas

India.—The largest production as yet is that of India, but its total is not more than 2 per cent. of the world's production. There is in India a production of probably 30,000,000 lb. of cocoons, used almost entirely in the country itself for reeling into raw silk, which is used in weaving goods for internal consumption; there is an importation of some two to three million pounds of raw silk, mainly low grades of Chinese, used for local weaving. A considerable importation takes place of spun silk yarns from Italy and Japan; these might be produced in spinning factories in India, but this industry is not developed, though the waste silk, which is the raw material, is produced there. Statistics are not of great importance, but the estimated production of India in 1916 was 31,012,000 lb. of cocoons, or 2,276,000 lb. of raw silk, and with 300,000 people employed in silkworm rearing, and nearly as many in reeling, twisting, etc. This refers, of course, only to the mulberry silk cocoon, grown in domestication; and we may distinguish the production of the Indian many-brooded races of silkworm fed on bush mulberry, in Mysore, Bengal, and Assam, from the production of the one-brooded European race, fed on tree mulberry, in Kashmir notably, and also to a small extent

in the Punjab. The latter gives a thread equivalent to that of the European races, while the former produces a thread of a different character, employed only in limited branches of silk manufacture, and mainly adapted to the indigenous silk weaving industry of the country.

As regards the improvement of Indian silk, elaborate enquiry has been made in India, and recommendations have been put forward for development; perhaps some day these will be acted on. From the point of view of the British manufacturer desirous of using Indian raw material, the main lines of improvement suggested by the Silk Production Committee were—the increased production of the fine one-brooded race of Kashmir, the Punjab and Patiala; the cultivation in suitable areas in the plains of the many-brooded Madagascar; the reeling of silk to a higher standard for export; the improvement in the preparation of waste silk, and the increased production of Eri, so that it should be available in large regular amounts, when spinners would be glad to use it. Trials have been made with improved Mysore silk reeled on a better method. Cocoons, reeled silk (locally reeled and Kashmir reeled), and fabrics woven from these are on exhibition in the Silk Section in the Palace of Industries.[1] There is no doubt that there is a market in England for good quality Mysore silk and clean waste; the properly reeled silk would fetch a price that would more than repay the extra cost of superior reeling and ensure a large demand.

The Kashmir Director of Sericulture has also attempted to improve the silk by rearing Bulgarian seed sent by the Committee; the silk is of good quality, specially suitable for use in England, and its cultivation is being extended. A further point is that the silk reeled in Kashmir is now being reeled in 13/15 and higher deniers, and is in consequence being used in larger quantities in England. Kashmir has reached the limit of its production, owing to the full use of the available trees, but improvement in quality will render the silk more suited to use in England. Fabrics

[1] Specimens of the different cocoons, silks and fabrics referred to in this paper, may also be seen in the Imperial Institute Section in the Pavilion of H.M. Government.

woven from Kashmir silk are on exhibition in the Silk Section. With the present prices of silk, which are likely to be maintained, it is to be hoped there will be production of this type of silk in other parts of India, and an extension of it in the Punjab.

There are, in addition, two other silks produced in India—one in domestication, the other wild. The former is the Eri silk, a many-brooded race that feeds on castor. It yields only a spinning silk, and it is now grown only in Assam. The surplus cocoons are exported, but the amount varies very greatly, and the available export production is very limited. With the higher values of spinning silks, it may be hoped that the production of Eri silk will again be taken up outside Assam. Fifteen years ago, when an effort was made to stimulate production of Eri, large quantities were produced, and spun in Bombay. It is possible to grow Eri in many parts of India, and the English spinner would welcome supplies. Fabrics from Assam Eri are on exhibition in the Silk Section. The other silks are the Wild Tasar and Muga, half domesticated or wholly wild products of Assam and of the forest areas of Chota Nagpur. The cocoons are reeled, the thread used locally, and the waste of the tasar exported to a limited extent or used in the spinning mills of Cawnpore. These silks are precarious productions, mainly of forest people, little organised, and not coming under the statistical observation of the authorities. Disease is an uncontrollable factor in production, the people practising the industry have other sources of livelihood, and the whole production is unorganised and uncertain. The question of its improvement and expansion has been fully dealt with already.

Cyprus.—The only other area within the Empire that produces silk is Cyprus, which has a production of some 140,000 lb. of dry mulberry silk cocoons of the one-brooded French or Italian races ; the cocoons are mainly exported for reeling to Italy and France. The total value of the cocoons is put at £30,000. There is scope for extension within the island, particularly if reeling is done there, and if a guaranteed demand for locally produced cocoons is created by the establishment of a filature. This ques-

tion has been the subject of much investigation, and it is likely that either a Government filature will be set up, or that private enterprise will do this with the encouragement of the Government. A material increase in production may be anticipated, and the Cyprus raw silk should become available as Cyprus silk, and not, as hitherto, be merged in the Italian or French silk reeled from the exported cocoons. Cocoons, locally reeled silk, and silk reeled in France, are on exhibition, and fabrics woven by Messrs. Warner & Sons from Cyprus silk are also in the Silk Section.

Other Countries

Elsewhere in the Empire there has been production of silk experimentally, and while it is impossible here to go over the history of all experiments, it is interesting to summarise the position. For this I am mainly taking the information which has been put before the Silk Production Committee of the Imperial Institute, which, under the chairmanship of Sir Frank Warner, has taken every opportunity to learn what was being done, by interviews with colonial officials when on leave in England. The Committee has helped with advice, with seed supplies, with reports on cocoons, and with test reelings and weavings of experimental silks. This Committee has been in touch with all the attempted silk production of the Empire in recent years, and from its records I have abstracted what is known of the present position.

Australia.—The Commonwealth has experimented, partly by a State silk farm in New South Wales, partly by the efforts of two enthusiastic Associations of New South Wales and Victoria. No practical results have been achieved. The climate is suitable, mulberry grows well, the worms are healthy, and several broods a year could be obtained. Cocoons were sent from New South Wales in 1916, and were wound, giving a good return and good quality; further cocoons were produced in 1920. Cocoons and silk are shown in the Exhibition. But the results of silk production, even on an ideal scale as to amount of mulberry and worms per unit, would be a poor return

as compared with that derived from farming or other less exacting occupations. Labour is too dear to enable sericulture to succeed with paid labour. As a cottage industry the earnings would not compare with those of farming, poultry keeping, and fruit growing. To smallholders, with, say, two acres of mulberry as part of the holding, with full knowledge of the methods of rearing, silk production might be a profitable subsidiary industry, if practised by a number of smallholders able to dispose of their cocoons to a single filature which was able to reel first-class silk. It would be an experiment worth trying, but it requires the best mulberry plant, properly grown, the best seed, properly reared, proper organisation of a number of producers, and a small filature ; and the requisite technical knowledge has not been available to promote this. In view of the splendid development of vines in Australia, it may be hoped that silk will also be developed eventually.

Hong Kong.—Silk has been produced here and sent for trial ; it was of good quality, but the production hitherto has been purely experimental. Locally reeled silk is exhibited in the Silk Section, and there is a prospect that in the New Territory a silk industry will develop.

Federated Malay States.—Silk was formerly produced here, but latterly the raw silk used in weaving was inferior imported Chinese. Owing to the very high humidity in the only possible areas, it appears that silk rearing cannot become an industry.

Ceylon.—Ceylon has experimented at different times with mulberry and Eri silk. The climatic conditions are suitable, the plant grows well, good cocoons are produced, but it seems unlikely that any industry in silk production will develop, chiefly as it is not an industry that appeals to the people.

Mesopotamia.—Silk had been formerly reared in the Diala area, and trees had existed sufficient to feed the worms from 5,000 oz. of seed. Mulberry silk rearing has been carried on experimentally since 1918 ; the people know about the industry (which is carried on in Persia), and the cocoons produced have been reeled in Kashmir

pending the development of a filature in Basrah. The seed used has been sent from Europe and Kashmir. In 1920, 500 oz. of seed were imported; the experiments were not successful, not on account of the want of mulberry, but owing to the absence of expert advice. This has now been rectified by the training of an Arab in Kashmir, and work has been commenced again. An early revival of the silk industry is anticipated if the Government give practical support in the provision of silk inspectors and mulberry tree nurseries. In 1922 silk to the extent of 20,000 lb. of cocoons had been produced, and the reeling trials made had shown very good results; those from the Bulgarian white seed better than from the Italian yellow. These cocoons and reeled silk are exhibited in the Silk Section. The next step is the establishment of a filature, so that there may be an export of raw silk and not of cocoons. It looks as if Iraq will shortly become a silk exporting country on a large scale.

Sudan.—The Sudan has no silk industry, but experiments with Eri have been discussed; the probability of any silk industry being developed is small, owing to the scarce population and the climatic conditions, but castor grows freely, and there might be a production of Eri, since reeling is not required. Cocoons have been raised and sent to England; development is probably a matter of the price obtained.

Kenya.—Cocoons from Cyprus seed were reared in Kenya in 1919, and sent to England. They were of good quality, and it was mainly a question of organising the industry. Further cocoons were reared in 1922, and were of exceptionally good quality. The Director of Agriculture has stated that certain tribes are already interested in the production, and could be trained to reel the silk. The prospects of a production of silk for export to England seem to be very promising. Cocoons produced in Kenya and silk reeled from them in France are on exhibition in the Silk Section.

Uganda.—Experimental cocoons have been produced from seed sent from Europe; the question is still under investigation, and the prospects are uncertain. The cocoons and silk reeled from them are on exhibition and

there is no doubt that good quality silk can be produced there.

Rhodesia.—Silkworms have been known to occur in Rhodesia for some years. In 1916 there were forty acres of mulberry trees derived from seed and cuttings sent from France and Cyprus; and while other parts of South Africa appear to be unsuitable, this area appears promising. Cocoons have been produced and tested, and an effort is now being made to interest natives in the production as a cottage industry. This applies particularly to Northern Rhodesia, and this is an area that offers promise.

West Indies.—The West Indies generally offer one feature of extraordinary interest in their ideal climatic conditions, a very vital factor in silk production. The conditions in the smaller islands vary very much in regard to the possibilities of cottage industries and the greater profits from other crops, but it is my personal opinion that we shall yet see sericulture established there as a real industry of great value. I urged this in 1911 in a paper read to the West India Committee, but a trial on a proper scale has not yet been made by either an agricultural department or any private interest. I still hope it may be done, as I am familiar with the conditions in the islands, and believe strongly in the value of the industry.

Experiments have been made in *Trinidad* with Eri and mulberry silk, both by the Agricultural Department and planters. Good cocoons were produced, the climate was suitable, but at that time the price was insufficient to attract smallholders into taking it up. Since then, in 1921, further experiments have been made, and the production of both mulberry and Eri is in progress. Cocoons are exhibited in the Silk Section.

The conditions in *Jamaica* are regarded as suitable for silk cultivation, and experiments are to be made. Silkworms have been reared at an elevation of 1,700 feet and good cocoons produced. It is probable that it would form a useful minor industry. Experiments are in progress, and there is a definite interest in this problem there.

British Honduras.—Here the question of silk cultivation has recently been raised, and the conditions examined. The only adverse feature is the high humidity, but trials are expected to take place shortly.

Silk Rearing

Mulberry Silk.—I think that you will forgive me if I go over very shortly the essential features of mulberry silk production so that you may all understand why I want to emphasise the factors which will determine the success of any efforts to produce silk.

The mulberry silkworm is fed on the leaf of the tree if the worm is of the one-brooded European or Japanese races, and on the leaf of the bush mulberry if of the many-brooded Indian or Madagascar race. The tree is cultivated in the ordinary way, but preferably not as a roadside tree, where it may get dusty. The bush is grown in various ways, but I think best as a well-pruned bush, about 6 ft. high, and planted, say, 6 ft. apart each way. In India the bush is cut right down to the ground every brood. The worms are kept on trays or some such devices; in Kashmir, where, owing to there being only one brood, trays would not pay, the people use their bedsteads, and all are occupied by worms during the rearing season. Feeding is done with chopped leaf several times daily, and the handling of young worms particularly must be done with nets or perforated paper. While the worms are moulting, they must not be fed or disturbed.

As the worms grow they must be given adequate space, and the area required is generally accepted as—for one ounce of seed (30,000) 3–15 sq. ft. in the first stage, 9–36 sq. ft. in the second, 36–90 sq. ft. in the third, 90–180 sq. ft. in the fourth, and 180–270 sq. ft. in the fifth and last stage before spinning. The trays, mats, or platforms may be in any building which is airy, sun- and rain-proof. A very simple structure suffices, and the trays may be placed on simple frames which can be so isolated that ants cannot get at the worms.

When the worms are full-fed, they require to spin and in Europe are placed on dry twigs arranged in an

arch, or on twigs loosely laid; the object is to give the worm a foundation which is airy and admits of the evaporation of the moisture from the wet silk. After several days the cocoons can be removed, some kept for breeding and allowed to emerge, the rest killed by exposure in a thin layer to the heat of the sun, or stifled in a hot chamber. The moths that emerge from the breeding cocoons are placed on paper in couples, usually under flannels, and there the female lays her eggs. If pébrine is suspected, she is microscopically examined for the organism, and the eggs rejected if it is found. If not diseased, the eggs are kept to hatch. If of the one-brooded race, they will not hatch without exposure to natural or artificial cold. (Some otherwise promising experiments have failed because this fact was not known and the experimenter waited patiently for eggs to hatch.) The only eggs that hatch naturally in a warm climate in a few weeks are the Indian and Indo-China races, the Japanese two-brooded race, and the Madagascar race produced by Grangeon from European stock. So that if one is rearing the one-brooded race, one must either get periodical supplies of seed from Europe or expose the seed to natural cold in a high altitude or to artificial cold in a cold storage plant. With regard to the cocoons, they are dried, and either at once or when sufficient have accumulated they are reeled off into raw silk. (It may be remembered that rats eat them.) The reeling is a technical business requiring simple appliances, and easily learnt by children, but it must be done properly, and the best quality produced that will find a market in Europe. As a rule, cocoons cannot be marketed, owing to their bulk and the cost of transport. One hundred pounds of green (undried) cocoons would dry to, say, 33 lb. of equally bulky dry cocoons, which would yield about 8 lb. of raw silk and 15 lb. of waste, both being in small bulk and easily transportable. An acre of bush mulberry would yield 16,000–20,000 lb. of leaf, say, in four pickings, sufficient to feed worms from 8 oz. of seed, yielding 800 lb. of green cocoons or 270 lb. of dry cocoons. The yield of good raw silk would be, say, 70 lb., of which an average price at present would be 25 to 40 shillings per lb. if from a

good one-brooded French or Italian race, and depending upon the quality of the reeling.

To grow silk successfully, certain factors are essential; the first is climate. The ideal climate has a temperature with a mean minimum of 55°F., a mean maximum below 90° if the percentage of humidity is between 65 per cent. and 85 per cent. A continued temperature of 85° with a percentage humidity of 85 is bad; with a lower percentage of humidity, a higher maximum temperature would not matter. Dry heat, say up to 100°, can be tolerated only if the humidity can be controlled and kept up reasonably. The best areas, so far as temperature goes, are those where there is a continued even warmth with fair humidity over the weeks in which the worms are feeding. Such areas are the hills in Southern India and Ceylon. The West Indian Islands have the ideal climate, but it is only necessary to have this for the time that the worms are feeding. In India the Mysore and Bengal areas are on the hot side except for certain periods, and it is at these that the big broods of the best silk are obtained.

The next factor is the cultivation, and here rainfall is the consideration rather than soil. In a long dry period, even if cool, mulberry may not give good leaf, and well distributed rainfall over the periods when leaf is wanted is the important thing. One may express it the other way, and say one grows a brood of silkworms when rainfall allows both of plant growth and good conditions for the worms. The variety of mulberry is important, and one grows either trees or bushes, usually of the soft-leaved *Morus alba*, which has only a small fruit; the coarse-leaved, big-fruited mulberries are suitable only when the single-brooded race is fed on the young leaves, and even then *Morus alba* and its varieties are preferable. It seems as if mulberry will grow on all soils given sufficient moisture.

The race of silkworms to use is of great importance; one may import eggs of the one-brooded European races, guaranteed disease-free, giving the very best quality of yellow or white cocoons. Such seed is produced in special establishments in France and Italy. If a many-

brooded race is the best, there is the possibility of the Madagascar race, developed from the European and available in India, where it is still experimentally maintained. It is a very technical matter to produce from a good single-brooded race a many-brooded race in a warm climate, but it can be done by artificial stimulus of the hatching of the eggs soon after they are laid and before they pass into the stage of development at which they cease growth until they have been through the cold. Any entomologist who will read the literature will see how to produce a many-brooded race suited to his conditions. Apart from this race, there are the many-brooded races of India, which come under three groups—the Chotapolo, the Nistari, and the Mysore. Under the moist, hot conditions of India they give a small fluffy cocoon, notable for its gloss. The best of these three is the Mysore. All improve when grown under better conditions of temperature and humidity. Miss Cleghorn, in Calcutta, has produced a race that is definitely better than the usual Indian races. I think the problem of what race to grow, where more than one brood is possible, resolves itself into trial of successive importations of European seed (to arrive when the conditions are suitable), trial of the Madagascar race, trial of Miss Cleghorn's white or yellow races, and trial of the Mysore. If time and opportunity permitted, one would experiment with producing a many-brooded race from the European, and with hybridising the one-brooded and the many-brooded races to get a many-brooded improved race. The great advantage of starting in new areas is that one can introduce what race one likes. In India, where the Mysore rearer, for instance, grows a definite race, one cannot introduce a new race, as that would be crossed with the existing one and so upset the quality and uniformity of the cocoons.

The next and most important factor is that the industry must be a cottage one, with small batches of worms grown by individual families. By a small batch I mean, say, one or two ounces of seed for each unit; you cannot successfully grow vast quantities of worms in immense sheds with labour; it must, so to speak, be a family business. All the work except the cultivation of the

mulberry is suitable to women and children; but it must be remembered that it is spasmodic in that as the worms grow they require more and more attention till they spin, when for a time there is nothing to do.

Lastly, the organisation of small reeling units to deal with the cocoons of a number of rearers is the ideal in starting the industry in new areas; this is not an easy matter, because reeling is a skilled occupation, and while children learn it readily, there must be someone in the first place to teach them; if there were only the organisation, one might be able to send a skilled reeler to each producing area to start the reeling on the best lines. I can only suggest the engagement, temporarily, of a reeler from Europe or India according to circumstances, for the time necessary to put reeling on a proper basis. Good reeling is absolutely essential, and the best policy in starting is to produce cocoons till there is a stock sufficient to keep reelers employed and then start the reeling. A native reeler in India with a small improved reel produces about 8 oz. of reeled silk per day; he uses about 2 lb. of dry cocoons per day, or 12 lb. per week, or something like 600 lb. per year. This is an estimate for small working on a simple scale, as one may have to do to commence. An acre of bush mulberry gives leaf for four broods of, say, 2 oz. of seed each; this provides, say, 250 lb. of dry cocoons for reeling, and so two such units (or families) would keep a reeler busy; for a small hand filature, employing, say, 6 to 8 children reelers and 4 preparers, etc., one would want a group of 6 to 10 families doing rearing as a subsidiary industry. An estimate for a modern small filature is that there shall be 300,000 lb. of green cocoons (the produce of 3,000 oz. of seed), yielding 25,000 lb. of raw silk and 15,000 lb. of waste, employing over 200 reelers, assistants, etc.

Eri Silk.—In discussing silk production, it is desirable to refer briefly to Eri silk. This is a silkworm that feeds on castor, that spins a cocoon that cannot be reeled but which is used in silk spinning. The cocoon is so made that it is not necessary to kill the chrysalis, as the moth emerges without injury to the cocoon. The cocoons, after the emergence of the moths, can be baled, and so

the transport problem, which penalises the sale of mulberry cocoons, is not so serious. Eri has several broods a year; its production on a large scale would be justified on present prices, but it must be realised that it is difficult to find a market for small lots of cocoons when large lots would be readily bought. In India it is spun by native methods much as cotton is, and locally woven; it has the advantage that there is no reeling, and so can be more readily used to introduce the idea of silk raising. Its food plant is also a common tropical plant, cultivated or wild, and since its seed is valuable, the leaf is available often in quantity without the cost of special cultivation. Where mulberry silk can be grown it is best to concentrate on that; but there are cases where Eri silk is suitable, and there is a definite market in England for good quality, clean cocoons.

Wild Silks.—These are under a different category from the domesticated mulberry and Eri silk; in India, Tasar and Muga are grown, and it is quite definitely known there what should be done to develop them. Elsewhere in the Empire the only wild silk of interest has been the *Anaphe* of Nigeria, Uganda, and Kenya. A great deal has been done with this in the way of getting cocoons, spinning, dyeing, and weaving them; *Anaphe* velvets woven in England are shown in the Silk Section of the Exhibition. There is the question of cultivating the worms; there is the very uncertain question of the amount of available wild supplies; in Nigeria especially this possible industry has been investigated, and the present position is that owing to the uncertainty of supplies and the small yield of silk fit for spinning, the prospects of *Anaphe* are not promising. The Silk Production Committee have made very careful tests of this silk, and the question is not finally settled; possibly there is a large production which might be available, and form a source of spun silk. It is a matter solely for this area, and there is no possibility of developing this silk elsewhere.

General Conclusions

There is an enormous market for good reeled silk, for waste, for Eri and for Tasar waste on the Continent and

in England. The tables in the Appendix are given to indicate the demand for silk and the proportion produced in the Empire. The first table, showing the world's production of raw silk may be summarised by pointing out that in 1920 the world's production was 20,380,000 kilos., in 1921 it was 29,295,000, and in 1922, 32,235,000 kilos. The second table gives the world's production of cocoons in each of the years 1917–1921. In 1921 production stood at about 276,000,000 kilos., apart from the Indian production which was used in that country.

The imports of raw silk, etc. into England during the years 1914–1922 are presented in Table III. Imports of raw silk vary from 1,030,500 lb. in 1914 to 976,279 lb. in 1922; of silk noils from 4,161 cwts. in 1914 to 2,343 cwts. in 1922; of knubs and waste, from 48,015 cwts. in 1914 to 35,601 cwts. in 1922; and of thrown silk, from 289,175 lb. in 1914 to 2,262 lb. in 1922.

Following a perusal of these tables, I think it may be asked, Why does the Empire produce so little silk, and why have we as a nation done so little to develop it? I think chiefly because we are not familiar with it, and when any development has been done in the tropics it has been in the direction of crops and stock, which we do understand. The French, with an important indigenous silk-producing industry, naturally develop it in the tropical areas that they administer; they also realise that silk is a technical thing, requiring proper skill, knowledge and conditions; we are apt to make a little tentative experiment with the wrong plant, the wrong race of silkworm, and without knowledge of reeling, and then the experiment fails or the experimenter is transferred elsewhere and his attempt ends. Even in India there is a record of many efforts which never developed because the initiator was moved away, and there is even now no great effort being made to expand and develop Indian silk, apart from the efforts of Mysore and Kashmir. The ultimate factor in silk production is, of course, price; given the proper conditions, does silk growing pay as compared with other crops?

Taking the yield of cocoons over the year as that from 8 oz. of seed, and allowing one shilling a pound for

green cocoons, gives a return of £40 per acre to the rearer; for the reeling and marketing that leaves £40 on the 64 lb. of raw silk (assuming 25*s.* per lb. is obtained, and that four reelers are at work for one month). These are, of course, figures for reasonably high yields where mulberry is properly cultivated, a high yield of cocoons got, and reasonably good reeling done. It allows nothing for waste silk at all. What are the fluctuations in price, and what does the future hold?

The position as regards price over the last two years has been this—the average price for "Italian extra 13/15 deniers" raw silk was in 1922, 39*s.* 6*d.* per lb.; in 1923, 39*s.*; the highest in 1922, 41*s.* 3*d.*; the lowest, 38*s.*; the highest in 1923, 44*s.* 6*d.*, and the lowest, 35*s.* The price is not a very fluctuating one, the demand is steady, and the world's consumption is enormous. A factor that seems to me to be extraordinarily important is the influence on silk prices of the price of cotton. If boll weevil and bollworm are not controlled, cotton prices will continue high or go up; with American cotton at 16 to 20 pence per pound, it begins to be worth while turning to waste and spinning silks as substitutes. Eri cocoons, if available in quantity, are going to be worth two to three shillings a pound; waste mulberry silk is going to go up. Mankind must have cotton, wool, silk, flax, or other fibre; and if cotton is going to continue to be high, so is silk. Fifteen years ago, when American cotton was 7.86 pence per lb. we could grow Eri and sell it to the spinning mills at 1*s.* 4*d.* per lb., for spinning; but had cotton then been 16*d.* to 20*d.* per lb., half India would be producing Eri silk now.

In this matter I am putting forward no opinion of the Silk Production Committee, but my own personal one, that over the next ten years is the time to try silk production in the Empire, wherever it can be produced. It must be a long time before the efforts of the Empire Cotton Growing Corporation make up the three or four million bales that America is short in; there will be high prices of other spinning materials and high prices of silk. Cotton is growing so expensive that cotton users are turning to silk; and I would like to see a real effort to grow silk in the Empire. What has been done since the

Silk Committee commenced in 1916 is an encouraging beginning; silk is being tried in new areas. The fact that silk is a possible industry at all is becoming known to all agricultural departments; the factors that make for success are getting familiar to all; technical help is widely needed, and especially as regards the reeling question and the organisation of rearing; but we are a slow people—slow to take up a new thing, unfamiliar with silk. I hope that the efforts that are being made will be persisted in till the difficulties are understood and surmounted; and the position as regards Empire silk production is very different from what it was before the war. We have every stage in development, from the small experimental production that has scarcely reached the reeling stage to the production, as in Iraq, where large scale production for filatures is possible. In India and Cyprus there is the possibility of great improvement in quality and immense increase in output; a few years of effort, aided by high prices, and we may see a large production of Empire silk available for the manufacturer within our own borders.

I am not here to-day to put forward any dreams of what might happen; but I think really it is worth considering in all the far-flung areas represented in this Exhibition if it is not worth while to really try silk and decide once for all, while conditions are good, if it cannot be produced. I hope I have indicated the points on which successful trials turn; as I have been unable personally to help on the technical manufacturer's side, I may be allowed to say that during all the time I have been on the Silk Production Committee I have seen every effort made there to help experiments forward with reeling, throwing, testing, and weaving; you are assured of ungrudging assistance, often at considerable cost, by Sir Frank Warner and his colleagues in the silk industry in this country. You can get the best technical information as to production, grades, qualities, faults, markets, prices, uses, and the like; and I think the experiments of the last ten years justify the hope that the Empire may number silk among its important products before many years are past. It rests now very largely with agricultural departments

and private enterprise in all parts of the Empire to push forward on the basis achieved, and help to make the Empire self-supporting also in this product, which is of universal demand.

APPENDIX

Statistics provided by the Imperial Institute, relating to the production of raw silk and cocoons, and the importation of silk raw materials to the United Kingdom, are given in the following tables.

TABLE I.—WORLD'S PRODUCTION OF RAW SILK[1]

Regions	1920 Kilos.	1921 Kilos.	1922[2] Kilos.
Western Europe	3,655,000	3,460,000	4,010,000
France	250,000	195,000	198,000
Italy	3,325,000	3,205,000	3,735,000
Spain	80,000	60,000	77,000
Eastern Europe, Levant and Central Asia[3]	750,000	550,000	700,000
Far East	16,425,000	25,285,000	27,525,000
China—Exports from Shanghai[4]	3,550,000	4,010,000	4,540,000
Exports from Canton	1,890,000	2,580,000	3,385,000
Japan—Exports from Yokohama	10,890,000	18,590,000	19,500,000
India—Exports from Bengal and Kashmir	80,000	85,000	75,000
Indo-China—Exports from Saigon, Haifong, etc.	15,000	20,000	25,000
Total	20,830,000	29,295,000	32,235,000

[1] *Statistics from l'Associazione Serica Italiana, Milan.*

[2] *Provisional figures.*

[3] *Comprises Hungary, Czecho-Slovakia, Yugo-Slavia, Rumania, Bulgaria, etc., Greece, Salonika, Adrianople, Crete, Anatolia (Brusa and region), Syria and Cyprus, the Caucasus, Turkestan and Central Asia, and Persia.*

[4] *Including Tasar silks, spun and native ("filatures" and "indigenes").*

TABLE II.—WORLD'S PRODUCTION OF COCOONS

	1917 Kilos.	1918 Kilos.	1919 Kilos.	1920 Kilos.	1921 Kilos.
Bulgaria	1,250,000	1,000,000	1,380,000	1,120,000	1,200,000
Spain	1,013,419	863,801	880,586	782,228	838,880
France	2,564,588	3,010,440	2,321,547	3,230,631	2,524,149
Italy	30,330,000	29,550,000	19,550,000	29,700,000	30,900,000
Switzerland	30,074	19,932	28,002	—	—
Cyprus	—	122,877	130,422	158,757	154,367
Indo-China	6,690,000	7,286,000	—	—	4,000,000
Japan	238,888,240	256,197,484	270,821,014	237,490,033	232,820,400
Corea	3,644,389	4,540,027	—	4,985,409	4,974,421
Formosa	25,112	31,145	31,064	—	—
Algeria	—	—	—	55	924
French Morocco	1,149	—	—	—	—

TABLE III.—Imports of Raw Silk, Waste Silk and Thrown Silk into the United Kingdom, 1914–1922

RAW SILK

—	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
France	132,712	102,258	30,146	3,493	13,853	45,057	15,106	9,886	7,754
Italy	131,750	363,456	311,013	186,258	129,416	202,409	106,576	107,319	200,528
Turkey—European	2,179	—	—	—	—	539	1,639	2,650	1,889
Asiatic	18,816	—	—	—	—	—	1,456	—	—
China (exclusive of Hong Kong, Macao and leased territories)	568,162	590,589	558,698	578,181	720,655	628,167	481,088	159,732	418,439
Japan (including Formosa and Japanese leased territories in China)	121,787	235,832	197,621	460,716	1,144,318	313,302	258,537	56,794	211,958
Other Foreign Countries	14,997	38,173	26,648	5,067	—	22,757	62,704	72,051	52,126
Total from Foreign Countries	990,403	1,330,308	1,124,126	1,233,715	2,008,240	1,212,231	927,106	408,432	892,694
British India	28,681	86,301	66,759	36,775	222,485	61,377	43,788	36,977	78,579
Ceylon and Dependencies	931	17,975	2,660	—	—	—	—	—	—
Other British Possessions	10,487	30,701	6,914	10,192	—	5,140	11,901	—	5,006
Total from British Possessions	40,099	134,977	76,333	46,967	222,485	66,517	55,689	36,977	83,585
Total	1,030,502	1,465,285	1,200,459	1,280,682	2,230,725	1,278,748	982,795	445,409	976,279

—	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
	£	£	£	£	£	£	£	£	£
France	110,426	77,519	24,207	5,616	21,230	54,780	26,031	17,802	14,146
Italy	105,606	285,330	325,788	247,883	212,374	412,575	282,011	183,885	377,708
Turkey—European	2,041	—	—	—	—	750	3,207	2,743	2,882
Asiatic	15,086	—	—	—	—	—	1,820	—	—
China (exclusive of Hong Kong, Macao and leased territories)	313,050	282,598	428,241	593,342	891,949	855,013	1,080,836	199,562	619,611
Japan (including Formosa and Japanese leased territories in China)	85,385	139,705	197,388	414,107	1,212,846	467,967	550,480	97,277	374,682
Other Foreign Countries	12,052	23,872	26,900	4,787	—	48,100	168,127	108,172	77,478
Total from Foreign Countries	643,646	809,024	1,002,524	1,264,935	2,338,399	1,839,185	2,112,512	609,441	1,466,501
British India	16,430	48,378	49,676	32,037	272,041	90,570	84,978	35,490	111,255
Ceylon and Dependencies	540	8,988	1,806	—	—	—	—	—	—
Other British Possessions	6,418	14,260	5,179	9,643	—	5,155	30,242	—	7,309
Total from British Possessions	23,388	71,626	56,661	41,680	272,041	95,725	115,220	35,490	118,564
Total	667,034	880,650	1,059,185	1,306,615	2,610,440	1,934,910	2,227,732	644,931	1,585,065

SILK NOILS

—	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
France	585	3,194	998	7	57	356	216	177	453
Switzerland	1,453	987	750	—	—	529	344	12	101
Italy	584	497	155	—	—	—	350	—	—
China (exclusive of Hong Kong, Macao and leased territories)	—	5,129	—	—	139	1,006	—	—	—
Japan (including Formosa and Japanese leased territories in China)	—	176	662	565	229	—	—	—	1,132
Other Foreign Countries	911	20	30	—	—	—	26	220	173
Total from Foreign Countries	3,533	10,003	2,595	572	425	1,891	936	409	1,859
Total from British Possessions	628	2,857	1,872	193	388	155	479	344	484
Total	4,161	12,860	4,467	765	813	2,046	1,415	753	2,343

—	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
	£	£	£	£	£	£	£	£	£
France	2,996	12,583	5,119	200	625	2,038	2,816	3,365	2,279
Switzerland	5,163	4,114	3,159	—	—	5,911	2,685	386	566
Italy	2,079	2,918	1,090	—	—	—	3,355	—	—
China (exclusive of Hong Kong, Macao and leased territories)	—	28,968	—	—	850	13,177	—	—	—
Japan (including Formosa and Japanese leased territories in China)	—	712	4,715	6,699	5,010	—	—	—	6,240
Other Foreign Countries	2,903	40	90	—	—	—	465	1,345	1,068
Total from Foreign Countries	13,141	49,335	14,173	6,899	6,485	21,126	9,321	5,096	10,153
Total from British Possessions	3,280	15,733	12,061	1,699	4,340	3,950	6,274	2,577	2,716
Total	16,421	65,068	26,234	8,598	10,825	25,076	15,595	7,673	12,869

TABLE III (*continued*).—IMPORTS OF RAW SILK, WASTE SILK AND THROWN SILK INTO THE UNITED KINGDOM, 1914–1922

SILK KNUBS AND WASTE

—	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	£	£	£	£	£	£	£	£	£
France	3,267	2,047	4,461	2,054	1,029	1,940	3,148	1,024	5,321	52,981	41,353	107,785	39,084	30,258	55,320	123,605	29,431	139,699
Switzerland	1,151	310	25	2	—	366	1,323	140	758	11,456	4,987	569	42	—	4,313	55,751	8,473	35,877
Italy	2,808	4,253	1,686	2,758	3,994	3,185	2,593	430	2,101	50,656	67,995	25,727	74,275	173,531	107,726	147,108	11,227	47,907
China (exclusive of Hong Kong, Macao and leased territories)	25,624	22,088	29,023	30,029	30,422	31,083	24,555	5,627	17,729	269,583	204,859	344,212	487,375	695,342	843,980	1,081,139	122,321	324,238
Japan (including Formosa and Japanese leased territories in China)	3,685	6,898	6,835	3,795	7,725	1,504	4,190	1,891	3,117	37,803	65,565	93,985	77,193	195,737	65,924	210,334	71,409	84,022
United States of America	160	593	470	82	40	—	105	—	253	1,567	8,272	8,094	1,318	915	—	2,405	—	4,729
Other Foreign Countries	569	148	750	312	117	242	795	575	566	6,585	1,997	14,389	6,265	3,365	10,296	43,676	21,592	16,057
Total Foreign Countries	37,264	36,337	43,250	39,032	43,327	38,320	36,709	9,687	29,845	430,631	395,028	594,761	685,552	1,099,148	1,087,559	1,664,018	264,453	652,469
British India	1,604	1,771	1,117	1,649	4,032	4,380	3,446	1,524	1,670	15,839	16,788	10,502	22,284	86,755	93,879	112,836	28,333	21,479
Hong Kong	8,995	7,493	5,566	3,535	1,609	871	1,293	65	3,904	89,181	60,870	57,019	46,165	32,622	18,012	46,571	3,390	71,790
Other British Possessions	152	288	99	253	116	119	29	42	182	1,885	2,435	1,133	3,704	2,000	4,880	880	700	2,612
Total from British Possessions	10,751	9,552	6,782	5,437	5,757	5,370	4,768	1,631	5,756	106,905	80,093	68,654	72,153	121,377	116,771	160,287	32,423	95,881
TOTAL	48,015	45,889	50,032	44,469	49,084	43,690	41,477	11,318	35,601	537,536	475,121	663,415	757,705	1,220,525	1,204,330	1,824,305	296,876	748,350

THROWN SILK: DYED OR NOT DYED

—	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	£	£	£	£	£	£	£	£	£
Germany	126,531	—	—	—	—	—	—	—	—	121,140	—	—	—	—	—	—	—	—
France	20,730	14,818	993	1,500	6,782	126,787	93,414	16,861	657	19,895	14,412	992	1,592	11,922	292,345	247,429	34,209	1,403
Switzerland	9,044	6,034	7,926	742	—	—	15,363	1,536	473	8,075	4,566	6,745	888	—	—	47,880	4,208	818
Italy	132,804	23,509	20,599	27,429	63,088	30,786	19,066	7,076	910	128,768	18,542	25,014	38,518	113,863	63,361	53,216	14,501	1,919
Japan (including Formosa and Japanese leased territories in China)	—	—	—	10,807	800	—	—	—	—	—	—	—	11,546	783	—	—	—	—
Other Foreign Countries	66	702	—	7,559	—	—	9	—	222	64	339	—	9,832	—	—	24	—	555
TOTAL	289,175	45,063	29,518	48,037	70,670	157,573	127,852	25,473	2,262	277,942	37,859	32,751	62,376	126,568	355,706	348,549	52,918	4,695

Discussion

In the discussion which followed the reading of Prof. Lefroy's paper, the Chairman (Sir Frank Warner, K.B.E.) stated that the great obstacle to the production of Empire silk was the lack of proper reeling establishments, such as now exist in Kashmir.

Mr. A. J. Solly said that he had some very satisfactory experiences with the working of Empire silk, more especially that from Cyprus. He mentioned that the Advisory Committee on Silk Production had received great help and encouragement from Prof. Lefroy, and that the silk trade owed an infinite debt of gratitude to Sir Frank Warner.

Mr. P. M. Elton, M.Sc., thought it a matter for very great congratulation that the Imperial Institute had taken up the question of increasing the production of raw silk within the British Empire. Seeing that the demand for silk within the Empire was at present comparatively small, it seemed to him an extraordinarily good venture and a good thing for them to have taken a real look into the future and to have tried to provide increased supplies of raw material for the industry.

The Chairman expressed himself as deeply indebted to Prof. Lefroy, not only for his paper but for the valuable assistance he had given to the Advisory Committee of the Imperial Institute, of which he was one of the most valuable members. Without Prof. Lefroy's aid the Committee could not have made the progress it had done, his world-wide experience of silk in all countries being just what they had needed. The Silk Production Committee had worked very hard during the last eight years to see if anything could be done to promote sericulture in the Empire. It was a work of slow progress. It had to be borne in mind, as Prof. Lefroy had pointed out, that sericulture was a cottage industry and its value had to be brought home to people individually. He was hopeful that they would succeed ultimately in establishing sericulture in those parts of the Empire where conditions are favourable and he appealed to manufacturers and others in this country to support the movement.

CEMENT MANUFACTURE AND ITS POSSIBILITIES IN THE CROWN COLONIES AND PROTECTORATES

PART I

THE manifold uses of cement and especially its employment for the manufacture of concrete, which is so largely used at the present day in place of brick and stone for structural purposes, render it of no little importance that all countries should be able to obtain cement for local use at a reasonable cost. In many overseas countries, particularly those remote from the present centres of production, the use of cement is greatly restricted owing to the heavy cost of shipment and the consequent high price of imported supplies.

Portland cement is already being made in large quantities in several countries of the Empire, such as Canada, Union of South Africa, Australia, New Zealand and India, whilst operations on a smaller scale are being carried on in the Sudan, Rhodesia, Federated Malay States and Straits Settlements. It seems probable that the raw products required for cement manufacture exist in nearly all parts of the Empire, but the selection of the most suitable materials in any country is a matter for expert investigation and has to be considered in relation to other questions, such as the extent of the deposits and the proximity of sufficiently large markets to the sites where works would be erected.

The Imperial Institute has devoted considerable attention in recent years to the possibilities for cement manufacture in many British possessions; a fully equipped cement laboratory has been installed, and raw materials have been investigated from several localities, including Nigeria, Nyasaland, Kenya, India, Ceylon, Fiji, Jamaica and Newfoundland.

This cement laboratory includes all plant necessary for (1) the mechanical preparation of large samples of raw cement materials, (2) the carrying out of experimental burning trials, and (3) the testing of the finished cement in order to ascertain whether it conforms to the standard

specifications in force in Great Britain, the Dominions, the Crown Colonies or elsewhere as may be required.

As a general rule representative samples of raw material are first submitted to chemical analysis, and if the indication so obtained is favourable, burning trials are carried out. The resultant cement is then fully tested in order to ascertain whether it conforms to the recognised standards as regards composition and strength.

In addition to the investigation of new sources of raw materials, commercial cements are also tested at the Institute. For example, according to the regulations of the Argentine Government all cement imported into that country for use in Government work must be accompanied by a certificate of quality issued by a laboratory recognised for that purpose by the Government of the country of origin, and in 1915 H.M. Government appointed the Imperial Institute to act as the authority for the necessary tests and to issue certificates for cements supplied by firms in Great Britain. In order to conform with the requirements, the Institute Inspectors attend at the works of the company desiring to ship the cement, and take samples which are tested at the Institute in accordance with the requirements of the Argentine Government specification. If the cement is found satisfactory, the Institute's representative inspects the loading of the cement and the requisite certificate of quality and shipment is then issued. This involves the testing of several hundred samples of cement each year, and special machinery and apparatus have been devised in order to deal with the work.

Some general idea of the principal cement-testing laboratory at the Institute will be obtained from the photographs on Plates III and IV. The laboratory in which are carried out the chemical analyses of the raw materials and finished cement is shown in Plate V.

In the present article an outline is given of the manufacture and properties of different kinds of cement, special attention being devoted to the characteristics required in the raw materials used for the several classes of cement now employed in building. This is followed by particulars relating to the possibilities of cement manufacture in

PLATE III.—IMPERIAL INSTITUTE CEMENT TESTING LABORATORY

PLATE IV.—IMPERIAL INSTITUTE CEMENT TESTING LABORATORY

the Crown Colonies and Protectorates; under each country is given an account of the deposits so far known, results of tests carried out at the Institute, and a discussion of the prospects of establishing a cement-making industry.

Manufacture and Properties of Different Cements

Calcareous cements, as distinct from common building limes and plasters, can be roughly divided into the following groups (each of which has its own special characteristics), arranged in order of their strengths: (*a*) Portland cement (sometimes called artificial Portland cement), (*b*) natural cement, (*c*) grappier cement, (*d*) hydraulic lime, (*e*) Puzzolana cements.

Portland Cement

This material is produced by burning at a suitable temperature (1300° to 1500° C.) a finely ground mixture of calcium carbonate (chalk, limestone or marl) and a silicate of alumina (clay, mud, shale or slate) in suitable proportions.

As the ultimate chemical composition of the mixture is of considerable importance the raw materials have to be carefully proportioned. As a general rule, the composition of a good Portland cement which will conform to the requirements of the British Standard Specification, lies within the following percentage limits: lime, 60 to 65; magnesia, 0·5 to 3·0; silica (combined), 20 to 25; silica (free), 0·2 to 1·0; alumina and iron oxide, 5 to 12; sulphuric anhydride, 0·2 to 2·0. Certain foreign specifications differ in some respects from the British one; for example, the German and American specifications allow a maximum of 5 per cent. of magnesia.

It is now generally agreed that most of the lime in a well burned Portland cement occurs as tricalcium silicate ($3\,CaO, SiO_2$) and it is to this substance that the cement largely owes its hydraulic properties.

In addition to the normal Portland cements which conform to the above limits, there has recently been produced in France a material, known as "ciment fondu," "ciment électrique," and "électro-ciment," which is made by fusing together in the electric furnace approximately equal parts of lime and bauxite. These cements differ considerably from Portland cement in chemical composi-

tion (see p. 185). Their most important feature is the fact that they attain high compressive and tensile strengths within one day from gauging.

In another variety, known as "iron-Portland" cement, much of the alumina is replaced by iron oxide. This cement is stated to be particularly resistant to sea water.

It is evident that the most essential raw materials for the manufacture of Portland cement are a fairly pure source of lime, such as a good limestone or chalk, and a suitable argillaceous material, the selection of which depends on its composition in relation to that of the limestone employed.

Calcareous Materials.—The calcium carbonate necessary may be in the form of chalk marl, chalk, limestone, coral, alkali waste or blast furnace slag.

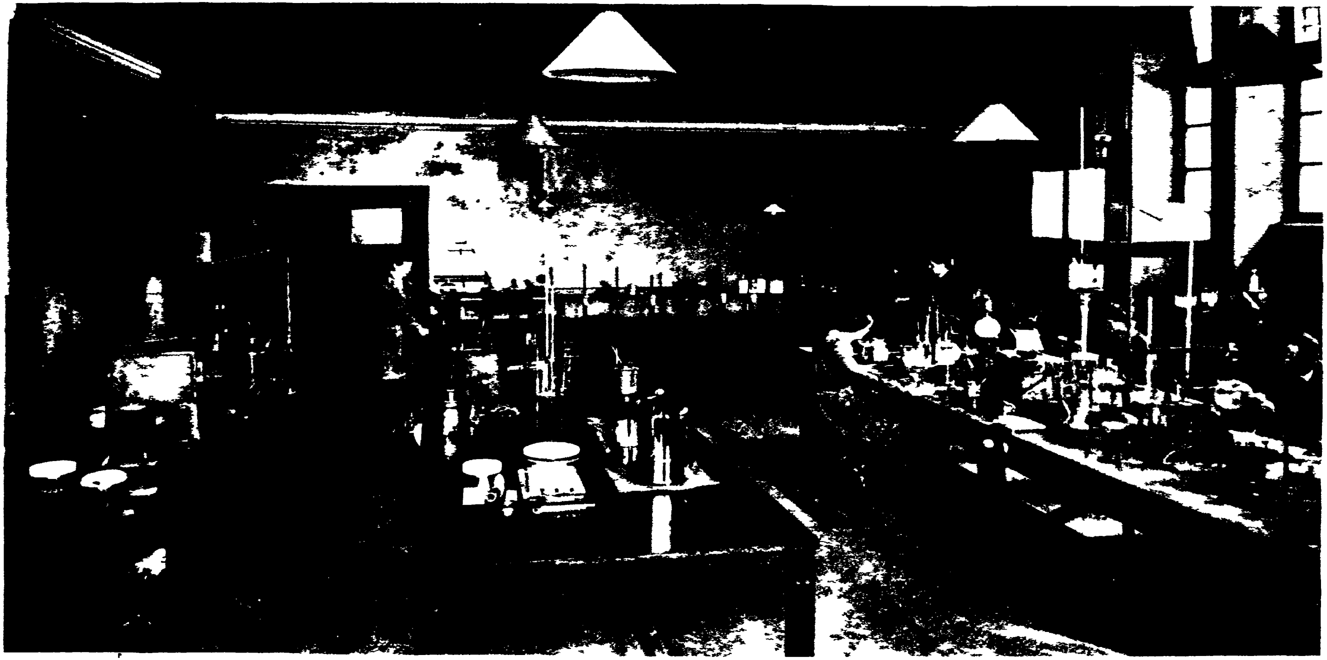
Owing to the necessity for securing a very intimate mixture of the calcareous and argillaceous materials in making Portland cement, soft chalk and chalk marl, being easily reduced to a fine state of division, are the most suitable calcareous materials when available in quantity, as is the case in Great Britain in certain localities on the Thames and Medway.

For use in making Portland cement which will conform to the requirements of the British Standard Specification, a limestone should not contain more than about 2 per cent. of magnesia and even less if this constituent occurs also in the clay employed. Other impurities which may be present are often of considerable importance. Thus silica sometimes occurs in the limestone in the free or uncombined condition as quartz, flint or chert, and may then render the material almost useless for cement manufacture, but when present in a combined state, as mica, hornblende or serpentine, it is less objectionable. Silica may also occur in a limestone in combination with alumina as finely disseminated clay, in which form it is very useful in cement making if not present in too large a quantity.

Iron oxide, carbonate and silicate in small amounts form useful fluxes, but iron sulphides, such as pyrite, are objectionable if present in amounts of much over two per cent.

It may be remarked that a pure limestone is usually

Plate V Imperial Institute Mineral Laboratory



more difficult to grind than one containing a fair quantity of argillaceous impurity.

In the following table is shown the chemical composition of some calcareous materials which are used in the United Kingdom in the making of Portland cement.

		Medway White Chalk.	North Wales Limestone.	Blue Lias Limestone.	Alkali Waste.	Cambridge Marl.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	42·92	54·84	42·76	48·29	41·44
Magnesia	MgO	0·42	0·26	1·72	1·51	0·44
Iron oxide	Fe_2O_3	0·20	0·41	2·90	1·38	2·76
Alumina	Al_2O_3	0·18		4·09	1·41	4·04
Sulphuric anhydride	SO_3	trace	0·09	*	1·26	*
Silica	SiO_2	1·36	1·14	13·31	1·98	18·20
Carbon dioxide	CO_2	35·36	43·26	33·61	39·60	32·56
Water	H_2O	19·03	*	*	3·80	*

* *Not recorded.*

Clayey Materials.—The argillaceous material to be incorporated with the limestone usually consists of clay, but occasionally shale, slate, or a very argillaceous limestone, is used. The clay selected should be as free as possible from gravel or coarse sand, as the silica present in such form is inert under the conditions of manufacture, unless it be ground very finely previous to burning—an operation not usually economically practicable. As a rough guide, it may be stated that clays containing much more than 5 per cent. of sand, which will not pass a sieve having 100 meshes per linear inch, will not be suitable for use in Portland cement manufacture.

The chemical composition of the clay may vary between fairly wide limits when it is to be used in conjunction with a limestone of good quality. The percentage of silica in the clay should not be below 55 and, preferably, should range between 60 and 70 per cent. The total amount of oxides of alumina and iron should not be more than one-half of the percentage of silica, and it is preferable that it should be about one-third. All the above limits will, of course, be modified if an impure or argillaceous limestone is to be incorporated with the clay.

In certain districts where a clay deficient in alumina is used, this deficiency is rectified by the addition of bauxite to the raw mixture. In other localities where a clay deficient in silica is used it is necessary to add finely ground sand.

Only small proportions of magnesia and alkalis should be present. Nodules of foreign matter such as pyrite, apatite or gypsum are undesirable.

As a general rule, "transported" clays are more suitable than "residual" clays, as the latter are apt to contain coarse fragments of quartz, chert or flint and to lack homogeneity. Estuarine muds are often a cheap and very suitable material.

Shales, which are generally "residual" clays that have been consolidated by pressure, are sometimes used where a suitable clay is not available; they are often of more regular composition than unconsolidated "residual" clays. Shale is used in a number of works in the United States where the two varieties of the material termed "normal" and "limey" are employed. The latter, however, are liable to vary from point to point and so cause difficulty in manufacture.

In certain localities there are available large quantities of waste, resulting from the splitting and dressing of roofing slates, which is suitable, as regards chemical composition, for use in cement manufacture, and such material is employed in a few works in Great Britain and the United States.

It should be noted that shale or slate waste have to be finely ground in order to secure intimate mixture with the limestone before being burnt, and hence the cost of preparation is greater than would be the case if a good clay were used. In the following table are shown analyses of certain argillaceous materials which are used in the manufacture of Portland cement.

		Gault Clay.	Medway Mud.	Michigan Shale.	Kansas Limey Shale.	Rockmart, Ga., Slate Waste.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2	33·28	58·70	62·10	54·4	58·20
Alumina	Al_2O_3	13·57	16·48	20·09	18·2	18·85
Iron oxide	Fe_2O_3	6·37	6·27	7·81	5·7	5·78
Lime	CaO	17·92	2·30	0·65	7·2	4·35
Magnesia	MgO	1·54	2·06	0·96	1·8	3·51
Alkalis	$\left\{\begin{matrix} Na_2O \\ K_2O \end{matrix}\right\}$	3·25	3·63	*	*	3·20
Sulphuric anhydride	SO_3	0·71	0·34	0·49	*	1·25
Carbon dioxide	CO_2	15·38 }	9·70	* }	12·3	0·60
Water	H_2O	7·98 }		* }		4·07

* *Not recorded.*

Fuel.—Besides the judicious selection of the abovementioned raw materials there is also the important question of fuel. The necessity for an adequate and cheap supply of fuel will be realised when it is stated that each ton of Portland cement produced in the modern rotary kiln entails the consumption of about half a ton of coal or its equivalent in lignite, oil or natural gas. This amount includes that required to generate power for grinding and transporting the raw materials and finished cement, and for burning the cement in the kiln. Although the coals used for the latter purpose vary somewhat, it may be assumed that the desirable features of a coal intended for use in a rotary kiln are a long flaming character and a production of ash not much exceeding 10 per cent.

It is interesting to note that in the United States in 1922 the percentages of the total Portland cement burned by the several fuels were as follows :

By coal alone	75·7
„ coal and crude oil	10·5
„ coal and natural gas	
„ crude oil alone	11·1
„ crude oil, coal and natural gas	2·7
„ natural gas alone	

Only one plant (employing 7 kilns) was run solely on natural gas.

Kilns.—The kilns used in the manufacture of Portland cement can be classified as (1) rotary, (2) continuous stationary, (3) intermittent stationary.

(1) The rotary kiln is specially suitable for the continuous production of large quantities of high grade Portland cement. Its fuel consumption is greater than that of kilns of the second group, being 6–7 cwts. per ton of cement produced, but it requires the minimum amount of labour for its operation. As a general rule it does not prove economical to install a rotary kiln plant for a lower output than 25,000 tons per annum.

A rotary kiln consists essentially of an inclined steel cylinder, 5 to 15 ft. in diameter and 60 to 250 ft. long, lined with firebrick. The mixture of finely ground raw materials is fed into the upper end of the kiln whilst the fuel (powdered coal, oil or natural gas) enters at the

lower end. The kiln is mechanically revolved slowly on its horizontal axis so that the raw mixture travels towards the hottest zone of the kiln, where the burnt clinker is discharged into coolers and is thence conveyed to the grinding plant.

The cement produced by the rotary kiln is usually of the very quick-setting variety and in order to make it suitable for general use a small quantity of ground gypsum, usually between 1 and 3 per cent., is added to the cement during grinding. This addition has the effect of delaying both the initial and final setting time of the cement.

Modern Portland cement is usually sold ground to a high degree of fineness, much of that produced in the United Kingdom leaving a mere trace of residue on a sieve having 76 meshes per linear inch and only about 5 per cent. on a sieve having 180 meshes per linear inch.

(2) The continuous stationary type of kiln is used in certain localities abroad where (*a*) it is desired to deal with a much smaller output than is economically possible with a rotary kiln, and (*b*) where labour is abundant and cheap and fuel is dear. These kilns are rarely used for Portland cement manufacture in the United Kingdom or the United States.

This type of kiln is an elaboration of the old vertical kilns used in lime burning with an arrangement for the continuous feeding of fuel and raw materials and withdrawal of cement clinker near the base. The output of cement varies from 10 to 25 tons per day of 24 hours, and the consumption of fuel for burning is equivalent to about 250 to 300 lb. of coal per ton of cement produced.

(3) Intermittent stationary kilns are now rarely employed although they were the earliest type used for making Portland cement. In these the kiln is loaded with alternate layers of the raw cement mixture (in the form of dried bricks) and fuel, the latter being coke or anthracite. The consumption of fuel in the kiln is about 25 per cent. of the weight of cement produced.

Natural Cements

In certain localities clayey limestones occur which, when burnt in lumps at a suitable temperature and finely

ground, give a product having hydraulic properties similar to those of Portland cement. Natural cement forms a useful building material where a cheap cementing substance much stronger than ordinary building lime is required, but not necessarily possessing the strength of Portland cement.

The group of natural cement materials is sometimes divided into (*a*) natural Portland cement and (*b*) natural cement.

Natural Portland cement, which is extensively manufactured in Belgium, is produced by burning a rock which contains the argillaceous and calcareous constituents in about the correct proportions for Portland cement. Natural Portland cements and natural cements do not attain the regularity of composition and physical properties found in artificial Portland cement, and those produced even from the same quarry may vary considerably.

Natural cement is made from rocks which differ somewhat in composition from the natural Portland cement rock. For example, certain of those used in the United States contain relatively large quantities of magnesia.

The following table shows the composition of the rock used in several localities for the production of natural cement.

Natural Cement Rock

		Belgian natural Portland cement rock.	Rosendale, United States of America.	New Albany, Louisville, U.S.A.	Falls City, Louisville, U.S.A.	Cement Stone, England.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2	15·75	18·34	9·69	13·65	16·90
Alumina	Al_2O_3	3·95	7·49 (Alumina and Ferric oxide)	2·77	3·46	6·73
Ferric oxide	Fe_2O_3	1·00		1·95	1·45	5·11
Lime	CaO	43·10	37·60	29·09	34·55	34·62
Magnesia	MgO	0·49	1·38	15·69	7·97	2·19
Sulphuric anhydride	SO_3	0·50	*	*	*	0·21
Carbon dioxide	CO_2	35·21 (Carbon dioxide and Water)	31·06	40·14	35·92	28·62
Water	H_2O		3·94	*	*	3·82

* *Not recorded.*

It is seen from the above that the composition of the raw materials varies considerably, particularly in regard to the amount of magnesia.

The manufacture of natural cement is a more simple and inexpensive matter than that of artificial Portland cement, as it only involves burning the material (almost

as quarried) and grinding the burnt product. The temperature required in many cases is considerably lower, varying from 900° C. to 1200° C. according to the composition of the rock, but Belgian natural Portland cement is burnt at a fairly high temperature.

Owing to lack of homogeneity of the raw material and variations in kiln conditions, a fair proportion (10 per cent. at least) of the material is unavoidably spoiled by over- or under-burning.

The fuel consumption will vary with the efficiency of the kiln and of the fuel. Thus it is stated that the consumption of coal per ton of natural cement produced in the United States varies from 2 to 6 cwts.

Even the higher of these figures compares favourably with the quantity required for the manufacture of 1 ton of Portland cement.

In the United States most of the kilns used in this branch of the industry are of the vertical continuous type and are fed with alternate layers of fuel and rock.

The burning of the rock causes almost all the carbon dioxide and water to be expelled and the lime and magnesia to combine with the silica, alumina and oxide of iron with formation of silicates, aluminates and ferrates of lime and magnesia. The burnt material will not slake with water, but after being finely ground and mixed with water it will set hard either in air or under water.

Natural cement of the type produced in the United States has usually to be employed fairly near to its place of production, as owing to its low value it will not bear heavy freight charges.

An idea of the relative values of American Portland and natural cements is afforded by the fact that the average selling price of natural cement at the works, for some years past, has been 65 per cent. of that of Portland cement. In 1922, however, the price per barrel at the factory was $1·76 for Portland cement and $1·45 for natural cement.

Hydraulic Limes and Grappier Cements

These groups have to be considered together, as the production of grappier cements is dependent on that of hydraulic limes.

Hydraulic limes vary in composition but include those cementing materials, produced by burning siliceous or argillaceous limestones, whose clinker contains a fair quantity of both free lime and silicate of lime. The free lime is sufficient to cause the clinker to slake and largely fall to powder when treated with water, but the silicate of lime gives the slaked material the property of setting or hardening under water. The quantity of free lime present should not be largely in excess of the amount necessary to effect the pulverisation of the burned rock on slaking.

It is essential that the silica present in the raw material should be in a fine state of division and evenly distributed throughout the mass. This is particularly necessary in the case of limestones containing only small amounts of the oxides of iron and alumina which normally act as fluxing agents.

In the following table is given the composition of certain hydraulic limestones which have been used commercially :

		Le Teil, France *Per cent.*	Plassac, France. *Per cent.*
Silica	SiO_2	14·30	11·20
Alumina	Al_2O_3	0·70	5·30
Ferric oxide	Fe_2O_3	0·80	4·60
Lime	CaO	46·50	35·50
Magnesia	MgO	not determined	5·85
Carbon dioxide	CO_2	36·54	34·35

The fuel consumption varies, but it may be assumed that the amount of coal required to burn the stone will be between 20 and 30 per cent. of the weight of hydraulic lime produced.

Hydraulic limestones are usually burned in kilns much resembling those used for making common lime, but as a general rule a higher temperature is necessary and hence an improved draught must be secured. The time and conditions of burning vary with the composition of the limestone used.

The hydraulic lime comes from the kiln in lumps, which are then slaked with as small a quantity of water as possible and left for ten days. At the end of this period slaking

is complete and the resultant mass consists of a fine powder containing some lumps of harder material termed "grappiers." These lumps, which consist largely of silicate of lime together with some underburnt rock, are removed by means of sieves and are next ground finely. A portion of the ground grappiers is returned to the slaked material in order to increase its hydraulic properties, and the remainder is sold as "grappier cement" (see table, p. 185).

Hydraulic lime and grappier cement are chiefly used where a high grade building mortar is required.

Puzzolana Cements

These comprise materials which will form a hydraulic cement when mixed with lime, such as certain types of puzzolana, trass, tosca, burnt clay, slag, etc.

The naturally occurring members of this class of cementing materials are found fairly widely distributed, but have never attained any considerable commercial importance outside Europe.

The puzzolana group, including trass and tosca, consist largely of materials of volcanic origin whose principal constituents are silica, oxide of iron and alumina, the silica being in such condition that it will combine directly with lime in the presence of water to give a hydraulic cement. As a rule, true puzzolana after being mined is finely ground, and occasionally slightly calcined before being marketed.

The composition of several puzzolanic materials is shown in the following table:

		Puzzolanas		Trass.	Slag.
		Vesuvius, Italy.	Auvergne, France.	Germany.	England.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2	44·5	46·05	54·0	30·0
Alumina	Al_2O_3	15·75	17·0	16·5	28·0
Iron oxide	Fe_2O_3	16·30	20·55	6·1	0·75
Lime	CaO	8·96	8·55	4·0	32·75
Magnesia	MgO	trace	trace	0·7	5·25
Alkalis	Na_2O, K_2O . . .	11·0	6·35	10·0	*
Water	H_2O . . .	3·5	1·6	7·0	*

* *Not recorded.*

An interesting product resembling a puzzolana cement is a mixture of lightly burnt clay and lime, which is stated to have been used extensively in the construction of the Asyut Barrage in Egypt in 1901. The burnt clay is ground to pass a sieve having 100 meshes per linear inch and then mixed with slaked lime and sand. The tensile strength developed by briquettes which after standing 12 hours in air and 1 year in water was as follows:

3 parts clay and 2 parts lime gave 272 lb. per sq. in. (average of 52 tests).

1 part clay and 1 part lime gave 239 lb. per sq. in. (average of 38 tests).

3 parts clay, 4 parts lime and 3 parts sand gave 259 lb. per sq. in. (average of 37 tests).

In each case the briquettes showed an increase in strength when tested at the end of a second year.

The degree to which the clay should be burnt in order to secure the best results appears to vary with the particular clay employed.

It seems probable that this method of producing a building material of moderate strength might be employed with advantage in certain parts of the British Empire.

Composition and Tensile Strength of Cements

In the following table is given the chemical composition of a number of the finished products, the manufacture of which has been briefly considered in the preceding pages:

		Portland Cement, Medway.	Ciment fondu.	Iron Portland Cement.	Natural Portland Cement, Belgium.	Natural Cement, Rosendale, New York.	Grappier Cement, France.	Hydraulic Lime,† Teil, France.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Silica	SiO_2	22·07	10·68	23·44	22·17	30·50	27·38	22·0
Alumina	Al_2O_3	6·87	44·32	2·98	4·60	6·84	2·61	2·0
Ferric oxide	Fe_2O_3	1·98	4·9	7·48	1·23	2·42	1·02	2·0
Lime	CaO	63·52	40·26	61·86	60·86	34·38	58·38	62·0
Magnesia	MgO	1·25	0·57	0·50	0·73	18·00	0·46	1·5
Alkalis	.	0·64	trace	*	*	3·98	*	*
Sulphuric anhydride	SO_3	1·44	0·44	1·72	*	*	0·43	0·5
Carbon dioxide	CO_2	0·51	*	*	1·46	3·78	*	*
Water	H_2O	1·47	*	0·69	0·48		*	*

* *Not recorded.* † *After slaking.*

The strength of each of the above types of products varies considerably in practice, but the following figures will convey some idea of their relative tensile strengths in lb. per square inch :

Tensile Strength.

—	Neat cement.		Cement + 3 parts of sand	
	28 days	*12 months*	*28 days.*	*12 months.*
Portland cement . . .	850	900	400	450
Ciment fondu . . .	1,100	—	550	—
Natural cement . . .	250	380	140	260
Grappier cement . . .	350	570	200	400
Hydraulic lime . . .	—	—	100	300

Cement-Making Materials of the Crown Colonies and Protectorates

WEST AFRICA

There is a steady demand in West Africa for cement for constructional purposes, and this seems likely to increase in the near future.

The quantity of cement imported into British West Africa during recent years is indicated by the following figures :

	1913. *Tons.*	1915. *Tons.*	1917. *Tons.*	1919 *Tons*	1920 *Tons*	1921. *Tons*	1922. *Tons.*
Nigeria . .	18,071	6,468	11,705	11,456	14,804	18,554	26,946
Sierra Leone .	2,265	1,338	958	1,112	1,167	1,280	1,372
Gold Coast[1] .	20,106	36,497	11,342	13,709	25,040	20,387	15,348
Gambia . .	455	159	1,100[2]	593	802	567	999
Total	40,895	44,462	25,105	26,870	41,813	40,588	44,665

[1] *Cement and lime* [2] *Estimated.*

It is possible that cement, if produced in British West Africa, might also find a market in the French Colonies of Senegal, Dahomey, Guinea and the Ivory Coast, and in other parts of West Africa. No recent figures are available regarding the amount of cement consumed in these countries, but it can be estimated at about 25,000 tons per annum.

Nigeria

The Mineral Surveys of Northern and Southern Nigeria, carried out some years ago in connection with the Imperial Institute, located a number of deposits of limestone. One of the most promising deposits, considered from the

amount available, is that occurring in Northern Kabba between Jakura and Wa, about 20 miles below Lokoja on the Niger. According to the report made to the Imperial Institute by the Principal Mineral Surveyor, the deposit consists of massive white crystalline limestone, about 1,000 feet thick, which is intercalated among soft biotite gneisses, quartzites, haematite and sericite schists. In the limestone itself there are streaks and bands of quartz-calcite-epidote-vesuvianite rock, but these form but a small part of the limestone.

An analysis, made at the Institute, gave the following results:

		Per cent.
Lime	CaO	51·35
Magnesia	MgO	4·43
Silica	SiO_2	0·40
Loss on ignition	$\begin{Bmatrix} H_2O \\ CO_2 \end{Bmatrix}$	43·50

Limestone of the quality represented by this sample contains too large a percentage of magnesia to permit of its being used for the production of a Portland cement conforming with the British Standard Specification. It is possible, however, that the average amount of magnesia in other parts of the deposit may be sufficiently low for the purpose.

The nearest deposits of fuel appear to be the lignite (brown coal) of Asaba, about 100 miles down stream on the Niger (see this BULLETIN, 1923, **21**, 329). This brown coal is long-flaming and appears to be well adapted for the manufacture of cement in rotary kilns. Udi coal also would probably be an excellent fuel for rotary cement kilns. If coke fuel were required for vertical kilns it would be possible to produce this from Udi sub-bituminous coal.

As regards aluminous material for combination with the limestone for the production of Portland cement, it is probable that the alluvium of the River Niger would be suitable, but no analyses are available.

If the Niger alluvium found within workable distance of the above-mentioned limestone deposit proves unsuitable for the manufacture of cement, it might be advantageous to bring the limestone to the Asaba district for burning as the brown coal is here overlaid by seams of good clay.

Near Idomi (Long. 8° 8′ E., lat. 5° 50′ N.), which is situated about 11 miles E.S.E. of Ediba on the Cross River, beds of good limestone, at least 40 feet thick, were found by the Mineral Surveyors. Specimens of the limestone were examined at the Imperial Institute with the following results:

		Per cent.	Per cent.	Per cent.
Lime	CaO	50·48	53·64	53·35
Magnesia	MgO	1·27	0·83	0·97
Ferric oxide	Fe_2O_3	0·87	0·53	0·71
Alumina	Al_2O_3	0·63		0·39
Silica	SiO_2	6·01	3·10	2·12
Loss on ignition	CO_2, H_2O	39·98	41·88	42·04
Potash	K_2O	0·32	not determined	not determined
Soda	Na_2O	0·41	not determined	not determined

All these limestones are suitable for the manufacture of Portland cement and could probably be used in conjunction with the calcareous shales which occur in the locality.

Near Imudum, about 5 miles E. from Ebom on the Cross River and the same distance S. from Ediba, there are thin beds of limestone and limestone breccia-conglomerate. A section of some 6 ft. of these rocks occurs in the Lokola stream.

Between Idomi and Ekoi Ibomi thin limestones occur close to the junction of the sedimentary rocks and the Oban Hills crystallines.

The country between Idomi and the Cross River consists of a highly calcareous series comprising good limestone, impure limestones and calcareous sandstones. The Idomi limestone beds dip N.W. in regular sequence, and it may be supposed that they strike N.E. and S.W. over a considerable strip of country and may meet the Cross River near Okurike to the south-west and also near Obabra to the north-east. It was suggested by the Surveyors that an examination of the banks of the Cross River at low water around these points might show an outcrop of the limestone. Near the Cross River, there appears to be an abundance of clayey material, well suited for cement manufacture.

In the Abakaliki district between Agalla and Ogumati outcrops of grey compact limestone containing fresh water fossils were found over a distance of 6 miles. Samples examined at the Institute gave the following results on analysis :

		I. Per cent.	II. Per cent.
Lime	CaO	51·58	52·37
Magnesia	MgO	0·81	1·22
Ferric oxide	Fe_2O_3	0·63	0·95
Alumina	Al_2O_3	1·03	1·13
Manganous oxide	MnO	0·27	0·11
Silica	SiO_2	4·30	2·80
Phosphoric anhydride	P_2O_5	0·41	0·15
Loss on ignition		40·68	41·66

Sample No. 1 was obtained at Agalla and No. 2 from a stream between Agalla and Ogumati. Both would be suitable for making Portland cement.

At Inkamaru, between Udi and Abakaliki there are beds of good and poor limestones, within a mile of the Western Aboyne or Abomia River, a large stream, which is probably navigable for canoes all the way from the Cross River to beyond Inkamaru. This is the same stream as that known as the Adamaya, crossed by the Afikpo-Abakaliki road, near Abba. It is navigable for small launches from this crossing to the Cross River.

Outcrops located in the village of Inkamaru were found to consist of alternating series of crystalline and earthy limestones and calcareous sandstones. The thickness of the several beds could not be definitely ascertained, but evidence showed that three of the beds of crystalline limestone aggregated 12 feet in thickness. Analysis at the Institute of a grey limestone from this source gave the following results :

		Per cent.
Lime	CaO	38·50
Magnesia	MgO	0·69
Ferric oxide	Fe_2O_3	3·50
Alumina	Al_2O_3	4·08
Titanium dioxide	TiO_2	0·22
Potash	K_2O	0·32
Soda	Na_2O	1·15
Silica	SiO_2	20·30
Loss on ignition		30·85

Material represented by the above analysis would be too siliceous for use in making Portland cement, but would

probably give a natural cement if burned at a suitable temperature.

At Ikpopo Hill, 'Mmakor, near the River Enyong, between Aro-Chuku and Bendi, there are outcrops of good limestone. This deposit occurs about 2 miles from the Enyong, and it was stated that if the river is navigable for large canoes (as it apparently is in the wet season), lime, made locally from these rocks, could be transported down to the Cross River.

At Odukpani, about 8 miles east of Okoyong on the Calabar River, there is a thick series of limestones, extending across the telegraph line for about ½ mile. They are variable in quality, most of them being more or less sandy, though some of them are very fair limestones. They have here a total thickness of some 120 ft.

Analyses made at the Imperial Institute on samples of grey limestone collected in the neighbourhood of Odukpani gave the following results :

		I. Per cent	II. Per cent.	III. Per cent.	IV. Per cent.
Lime	CaO	37·48	47·28	48·94	31·87
Magnesia	MgO	0·65	0·79	0·83	0·74
Ferric oxide	Fe_2O_3	0·79	0·47	0·70	0·47
Alumina	Al_2O_3	5·24	2·13	1·32	4·83
Potash	K_2O	1·50	0·50	0·38	2·07
Soda	Na_2O	1·14	0·39	0·37	1·37
Silica	SiO_2	22·97	10·45	8·48	35·05
Carbon dioxide, Water	CO_2, H_2O	30·10	37·65	38·62	23·68

If used in conjunction with a clay low in silica, it is possible that material represented by sample No. III might be employed for the manufacture of Portland cement; the remaining samples are too sandy for this purpose. Technical trials showed that samples Nos. II, III and IV could be used for the production of hydraulic lime, and it is probable that if burned at suitable temperatures samples I and IV would give natural cements.

Similar sandy limestones were found about 3 miles north of Odukpani by the Mineral Surveyors, who were of the opinion that better limestones probably occur in this district and in other portions of the basin of the lower Calabar River, and that the country is worth further

examination owing to its fine system of waterways and consequent easy and cheap means of transport.

On the Akpa Iyefe River below Holiness Plantation, near the Cameroon border, a thin bed of limestone occurs, which, on being tested at the Imperial Institute, produced a white lime of excellent quality, suitable for use in the manufacture of mortar or cement.

At various points on the railway between Oshogbo and Ilorin deposits of limestone have been reported. A sample examined at the Imperial Institute consisted of irregular concretions, somewhat porous but on the whole compact and tough. These concretions were composed of an intimate mixture of clay and calcium carbonate, together with a small proportion of sand. The sample on analysis gave the following results:

		Per cent.
Lime	CaO	38·38
Magnesia	MgO	0·93
Ferric oxide	Fe_2O_3	2·01
Alumina	Al_2O_3	9·52
Titanium dioxide	TiO_2	0·42
Silica	SiO_2	15·14
Carbon dioxide	CO_2	28·09
Water	H_2O	4·67

The above composition indicates that the material is probably a natural cement rock, but the sample received was too small for technical trials to be made.

From the above it is evident that in Nigeria cement materials occur, which are worth further investigation and technical trial with a view to establishing a cement industry for supplying West Africa.

Sierra Leone

There seems to be but little prospect of finding in Sierra Leone suitable materials in sufficient quantity for cement manufacture.

The Report of the Geological Survey of Sierra Leone for 1921 states that "the sedimentary rocks of Sierra Leone, like those of the neighbouring parts of French Guinea, are remarkably deficient in limestone." It is noteworthy that during two seasons' work the officers of

the Survey found only one piece of true calcareous rock, and that was probably material brought by a vessel. Lime for local use is made by calcining marine shells found in mangrove swamps around the coast, but such a source would prove inadequate for cement manufacture.

Gold Coast

Limestone from several localities has been described in the *Annual Reports of the Government Geologist.* Grey and yellow limestones occur near the junction of the Afram and Volta Rivers north of Pessi, and preliminary chemical analyses have shown that they could be used for cement making. A similar limestone, about 170 ft. thick, has been found in the bed of the Afram River about 1½ miles east of Kuraji, and another in the bed and bank of the Obirrim River (a northern tributary of the Afram), where the recorded thickness is 12 ft.

In the Swipe district, north of the Black Volta river, extensive beds of limestone have been observed and are stated to be probably of good quality.

It seems likely that all the above limestones could be used for the manufacture of Portland cement providing that they occur in proximity to a good supply of suitable clay. The limestone and shale of Kade mountain are also worth consideration.

Grey clayey limestone outcrops in a few localities on the right bank of the Volta River between Obosumanu and Nkami. This material, if available in quantity, would be worth technical trial for the production of "natural cement."

As no deposits of coal or lignite have been located in the Gold Coast Colony, the fuel necessary for cement manufacture would have to be imported, unless it were found possible to utilise wood charcoal in one of the older types of kiln.

British Togoland

In Western Togoland both sedimentary and metamorphic limestones have been found in several localities. According to a report by T. Robertson, B.Sc., the Geologist in Togoland, the sedimentary limestones are usually

siliceous and argillaceous and often thin-bedded or lenticular. The metamorphic crystalline limestones appear to be lenticular and discontinuous.

Analyses of the sedimentary limestones quoted in the report are as follows: No. 1 is an argillaceous limestone in the bed of a tributary of the Ataulo River between Kpandu and Dukluja; No. 2 is an argillaceous limestone from Tanja River north-west of Wapuli, and No. 3 a limestone from Tupe River on the road from Nafekele to Gujoni.

		No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Lime	CaO	19·34	17·31	27·32
Magnesia	MgO	1·59	1·39	1·05
Ferric oxide	Fe_2O_3	6·24	3·55	1·87
Alumina	Al_2O_3	9·09	12·30	7·52
Titanium dioxide	TiO_2	0·87	0·40	0·26
Silica	SiO_2	41·73	44·01	34·73
Phosphoric anhydride	P_2O_5	0·26	0·15	0·35
Carbon dioxide	CO_2	14·15	12·96	21·23
Water	H_2O	3·97	3·50	2·60

Such low grade limestone would not be suitable for use in the manufacture of Portland cement but might possibly give a hydraulic lime.

(*To be continued.*)

NOTES

Cotton Research Board, Egypt.—In this BULLETIN (1920, 18, 117) reference was made to the establishment in Egypt of a Cotton Research Board and a short account was given of its constitution and objects. The *Third Annual Report, 1922, of the Cotton Research Board* (Government Press, Cairo, 1924) which has now been issued, contains interesting particulars on special questions which have been considered by the Board; details of the experimental work on cotton carried out during 1922 by the botanical, agronomic, entomological, chemical, and physical sections, and the agricultural service of the State Domains Administration; the programme of experimental work planned for 1923; and summaries of the principal publications of the Egyptian Government relating to cotton, and of certain non-official publications bearing on the Egyptian cotton industry.

There are a number of appendixes to the *Report*, giving statistics of areas and yields, meteorological data, notes

on the state of the Nile from March to October, 1922, particulars of the fluctuations in the prices of Egyptian cottons in 1920, 1921, and 1922, and other useful information.

Of special interest is a table recording the areas devoted to the different varieties of cotton in each of the years 1905–1922. This table is reproduced below but, owing to limitations of space, only the figures for alternate years are shown.

Areas Devoted to the Different Varieties of Cotton

(thousands of feddans[1])

Variety.	1905.	1907.	1909.	1911.	1913.	1915.	1917.	1919.	1921.	1922.
Ashmouni	294	300	252	330	356	232	362	334	117	276
Abbasi	35	38	24	33	37	7	3	4	1	3
Joannovich	73	157	199	251	173	29	2	—	—	—
Mitafifi	1,155	1,067	1,053	846	624	210	97	35	7	8
Assili	—	—	—	—	66	50	38	21	6	8
Nubari	—	—	63	115	201	107	39	24	9	11
Sakellaridis	—	—	—	120	247	548	1,133	1,146	995	1,358
Zagora	—	—	—	—	—	—	—	—	93	127
Pilion	—	—	—	—	—	—	—	—	0·3	—
Other varieties	11	42	7	16	18	4	3	9	10	10
Total	1,568	1,604	1,598	1,711	1,722	1,187	1,677	1,573	1,239	1,801

[1] 1 *feddan* = 1·038 *acres*.

This table exhibits certain very striking features. It will be observed that the planting of Ashmouni cotton, the principal variety grown in Upper Egypt, has been maintained fairly regularly throughout the whole period. On the other hand, the area devoted to Mitafifi, the variety which at one time constituted the bulk of the crop of Lower Egypt, has steadily decreased, whilst a rapid development has taken place in the cultivation of Sakellaridis which now occupies almost the whole of the area planted with cotton in Lower Egypt.

Pink Bollworm.—The most important of the special questions dealt with by the Board is that of the pink bollworm (*Gelechia gossypiella*), and the following notes from the report on this subject are of interest.

It is already known that the life-cycle of the pink bollworm is of two different types, one in which the larvæ pupate immediately they are full grown and emerge a few weeks later as moths, and the other in which the larvæ, when full-fed, make a cocoon of silk, usually between two cotton seeds, and remain in this in the larval stage without feeding for months before leaving it to pupate. These two types are termed the many short cycle and the long cycle or resting larvæ respectively.

Dr. L. H. Gough, Director of the Entomological Section, Ministry of Agriculture, has shown that there is also a third type which feeds slowly during the winter in fallen bolls, and this probably consists of late short cycle larvæ in which development has been delayed owing to the fall in temperature ; these are referred to as the slow cycle larvæ.

The regulations at present in force in Egypt, which prevent the growing of cotton or other host plants of the pink bollworm after November 30, render it almost impossible for any short cycle worms to survive the winter. Moths from the slow cycle type appear too early in the year to affect the cotton, and it is from larvæ of the long cycle type that the whole of the infestation of the following year is derived.

The long cycle worms appear in small numbers about the middle of August and the proportion gradually increases until by the end of November all but a very few are in the resting-stage.

At the end of August, larvæ, mostly of the short cycle type, are present in bolls on the plant and a few in the fallen bolls on the ground. In September the first picking takes place and many worms, including a small percentage of the long cycle type, are picked with the lint ; a further number of bolls containing larvæ fall to the ground and are trampled beneath the surface by the pickers. From the beginning of October the number of long cycle worms increases rapidly, and during this month a second picking is gathered which contains an enormous number of double seeds containing larvæ. These are carried with the lint to the villages and to the ginneries.

By the end of November there are left on the cotton stalks only dead bolls containing numerous resting larvæ and a few slow cycle larvæ. There are also many worms on the ground and buried in the ground in fallen bolls.

The cotton stalks are collected during November and December and are carried to the villages to serve as fuel. They are stored on the roofs of the houses, and any that remain until the summer constitute a danger as the bolls attached to them still contain larvæ which will hatch out and fly to the cotton fields. The bolls lying on and beneath the surface of the ground also carry the pest over from one year to the next and are probably at present the chief source of infection owing to the difficulty of dealing with them.

In order to prevent the spread of the pest from the larvæ in the seed-cotton, every ginnery is compelled to install a machine of approved type in which the seed is

kept at a temperature of about 57–60° C. for a sufficient *time to* kill all the worms, and this treatment is now so efficient that probably over 99 per cent. of the resting larvæ in the seeds are destroyed. There is, however, a danger that cotton may be kept long enough in the unginned state to allow the long cycle worms to emerge in the following spring and fly to infect growing cotton. A law has therefore been enacted, requiring that all cotton of the previous crop should be ginned by April 30 and that ginneries should cease work from that date until the new crop arrives.

The worms removed from the fields in the seed-cotton are thus now well under control, but much remains to be done with regard to the worms left behind after the picking. When the cotton plants are pulled up at the end of November, bolls containing worms are to be found (1) in the heaps of cotton stalks in factories and on the roofs of the houses in the villages; (2) by the edges of the roads and fields, where they have been dropped during the transportation of the stalks; (3) beneath the surface of the ground, buried at various depths; and (4) on the surface of the ground in the fields.

In order to deal with the cotton stalks, it has been proposed that it should be made compulsory for all bolls to be removed from the stalks before they are taken from the fields. Another method suggested is that all the stalks not consumed as fuel by the end of April should be burned. Both these methods, however, have proved impracticable owing to the difficulty of enforcing them without the assistance of a very large number of inspectors. A third method, compulsory boll collecting, has also been proposed (see below).

The scattering of the bolls along the edges of the roads and fields can only be stopped by the compulsory stripping of the bolls from the stalks and subsequent examination to see that they are free from worms. This has been tried and found to be impracticable for administrative reasons.

The bolls left on and under the ground are probably the most serious source of re-infection at present. An attempt which was made to sweep up all the bolls on the surface of a field did not result in any considerable reduction in the infection in the following year and scarcely justified the labour expended. The importance of these bolls left in the field almost certainly depends on the conditions to which they are exposed during the winter and on the crops which are grown in rotation. The question is now being investigated in both field and laboratory.

There is still one other possible method of dealing with the bolls left after picking has been finished which may be worth trial. Dr. Gough has suggested that every cultivator should be compelled to bring in a certain quantity of dead bolls for each feddan planted with cotton and that these should be taken to some central place where they would be checked and destroyed. This could probably be done if previous calculation were made to find the probable average quantity per feddan to be expected and a small fine imposed for any deficiency in the amount brought in and a small reward given for any bolls delivered in excess of the required quantity.

The damage caused by the pink bollworm might be reduced by the production or discovery of a variety of cotton which would give an earlier crop and this question is being carefully studied by the botanical section of the Cotton Research Board. The advantages would be (1) that a larger proportion of the crop would be picked before the worm had attained its greatest abundance; (2) that it would be possible to make the date for the removal of the cotton plants earlier, when there is a smaller percentage of the dangerous long cycle worms in the bolls; and (3) that the close period, when there is no cotton on the land, would be longer and would include a longer period in the autumn when the soil temperatures are higher, and when more value may be expected from agricultural methods of control.

The Cotton Seed Bug (*Oxycarenus hyalinipennis*).—The results of an investigation of the so-called "lesser cotton stainer" have been recently described by T. W. Kirkpatrick, B.A., F.E.S., in *Bulletin* No. 35, *Technical and Scientific Service, Ministry of Agriculture, Egypt*, under the title of "The Egyptian Cotton Seed Bug (*Oxycarenus hyalinipennis*, Costa): its Bionomics, Damage, and Suggestions for Remedial Measures" (Government Press, Cairo, 1923).

The insect belongs to the order Rhyncota, sub-order Heteroptera, which comprises the true sucking bugs. It has hitherto received comparatively little attention from entomologists, probably on account of the fact that the injuries it inflicts are not conspicuous and cannot be compared with those caused by the boll weevil, the pink bollworm and certain other serious pests. Species of Oxycarenus should not be classed with those of Dysdercus as "cotton stainers" but should be termed "seed bugs." A review of the literature dealing with the damage done by these insects shows a great diversity of

opinion, some statements charging them with causing bud and boll shedding, staining, and weakening of the lint, whilst others regard them as producing little or no effect of practical importance.

Various cotton-feeding species of Oxycarenus are recorded from Africa, Asia, Australia, and South America, the majority being from Africa. *O. hyalinipennis* occurs abundantly throughout Egypt but is less common in the south than in the north ; it is also a common pest in the cotton-growing districts of the Sudan.

A full description is given of the insect in all its stages, and its life-history and habits are comprehensively discussed. It exists on sixteen host-plants besides cotton, and exhibits considerable dissimilarity in its behaviour on the different plants.

The injuries due to the cotton seed bug are all effected by the puncture of the coats of the ripe seed and the extraction of the juices from the embryo. This causes a reduction in the weight of the seed and a consequent decrease in the crop of seeds for oil-extraction ; it also damages the seeds used for sowing, rendering some incapable of germination, injuring the radicle of others but not so severely as to inhibit germination, and in other cases damaging the cotyledons. A fungus is often present on seeds which have been killed by the insect, but it is of no importance, being merely a saprophyte. Slight attack of the radicle does not appear to be deleterious as the seedling makes up for an initial set-back to its main root by the earlier production of numerous lateral roots. If the cotyledons are pierced, without the radicle being destroyed, the resulting seedling shows symmetrical dead patches on the cotyledon leaves but these do not appear to entail any permanent damage to the plant.

The decrease in the weight of the seeds owing to attacks of Oxycarenus naturally increases the ginning yield, sometimes very considerably.

Damage to the lint is only of secondary importance. Staining only occurs if the cotton is ginned very soon after picking while living bugs are still present ; in this case some of the insects are crushed in the gin and stain the lint a conspicuous reddish colour, sometimes with traces of green. This can be entirely avoided by spreading out the lint in the sun, by the use of open-meshed sacks to enable as many as possible of the bugs to escape, and by postponing the ginning for ten days after picking when all the insects will be dead and dried up. The dead bodies and cast skins of the insects render the lint slightly dirty but the amount of such dirt is insignificant in comparison

with that usually present in the form of fragments of dried leaves and capsules. The smell of the bugs is not permanently imparted to the lint.

It has been proved that the seed bug does not cause shedding of buds or young bolls (as has been supposed) and is not responsible for the production of "mabrouma" bolls (*i.e.* bolls containing locks in which the cotton has failed to develop properly).

The insect appears to be immune from either parasitic or predatory enemies; but a fungus (sometimes found growing on dead bugs) causes the destruction of some of them by choking up the spiracles. The only natural means by which the multiplication of the insect is checked are hostile weather conditions.

The most obvious method of control is to be found in connection with the places in which the insect passes the winter. Weeds on the banks of canals and irrigation channels should be destroyed. The bugs should be brushed off the trunks of trees and other places where they collect in large numbers on a cold morning and be stamped into the ground. Traps made of pieces of sacking tied on stakes and placed round the edge of a cotton field will collect vast quantities of the bugs, but the number of such traps required for a large field entails a great deal of work.

Other methods of control, such as hand-picking, traps of cotton seed, trap crops of *Hibiscus esculentus* (bamia) or of *H. cannabinus* (til), and the removal of all badly damaged bolls at the time of the first picking, are considered to be either useless or impracticable.

The damage to the seed can be checked by early picking; and it is thought that it might possibly be of advantage to make three pickings instead of the usual two.

Agricultural Development in the Cameroons.—In this BULLETIN (1922, **20**, 165) an illustrated article under the above title was contributed by F. Evans, Supervisor of Plantations, Cameroons, which gave a general description of the portion of the Cameroons now administered by Great Britain under mandate from the League of Nations, with special reference to the various estates developed during the German occupation.

Some of these properties have now been sold and the remainder will be offered for sale in October next, at Winchester House, E.C.2. They will be sold without reserve and there will be no restriction (as in former sales) with respect to the nationality of the purchaser. Full particulars may be obtained from Messrs. Burchell, 5,

The Sanctuary, Westminster, S.W.1., or Messrs. Hampton & Sons, 20, St. James's Square, London, S.W.1.

The Determination of the Activity of an Accelerator of Vulcanisation.—A paper under this title by Messrs. G. Martin, B.Sc., A.I.C., and W. S. Davey, B.Sc., A.I.C., who are working at the Imperial Institute in connection with the Ceylon Rubber Research Scheme, was read at a joint meeting of the Manchester Sections of the Society of Chemical Industry and the Institution of Rubber Industry on December 7, 1923. The investigation described, which is of a highly technical character, will be of considerable interest to rubber chemists and manufacturers. The paper has been published in the *Journal of the Society of Chemical Industry* of February 22, 1924 (Vol. XLIII, No. 8, p. 31T).

Natural Soda Production in East Sind.—A memoir on "The Alkaline Lakes and the Soda Industry of Sind," by G. de P. Cotter, issued by the Geological Survey of India (*Mem. Geol. Surv. India*, 1923, **47**, pt. 2), gives a full description of the alkaline and saline deposits in an area in East Sind, which includes the southern half of Khairpur State, the eastern half of Nawabshah district, and the northern half of the Thar and Parkar district. The crude salt produced is known as *chaniho*, the principal constituent of which in most cases is trona, the sesquicarbonate of sodium (Na_2CO_3, $NaHCO_3$, $2H_2O$). The area containing the deposits is entirely covered with alluvial clays or by wind-blown sand, no outcrops of rock being visible. It is bisected in a N.-S. direction by the East Nara Canal, which occupies the bed of the ancient river Hakpo or Lost River of Sind, and is fed from the river Indus. The Jamrao Canal leaves the East Nara Canal near the south boundary of Khairpur State, and runs S.W. into the Nawabshah district, finally turning south into the Thar and Parkar district. Roughly speaking the area covered by alluvial clays and silts lies entirely west of the Nara and south of the Jamrao canals; the country covered by wind-blown sand lies east of the Nara and north of the Jamrao canals.

The soil of a large part of the alluvial country is unfit for cultivation, being highly-charged with sodium salts (*reh* or *kalar*), chiefly the chloride. A few halophytes, chiefly of the Goosefoot Order, grow in this soil, and incidentally, it might be mentioned that from their ashes a crude carbonate of sodium (*barilla* or *sajji*) is extracted. The alluvial country is fairly free from large sand dunes, but incipient crescent-shaped dunes (*barkhans*) are common.

In the area covered with wind-blown sand, the sand is formed into long parallel ridges (*bhits*) in the direction of the prevailing monsoon winds, which vary in different parts from N.E. to N.N.E. The most southern part of the sand-covered country in the Khipro *taluqa* (revenue district of the Salt Department) is characterised by long parallel sand-hills, between which, at the bottoms of the valleys (*talis* or *tullees*), is the old alluvial soil at or close to the surface.

In the southern part of the Khairpur State west of the Nara Canal, and also east of it for a distance of twenty-five miles, the bhits have in places almost a haphazard appearance, and form a region of small oval-shaped talis, some of which contain shallow lakes (*dhands*), whilst some are dry and studded with certain green shrubs and trees.

A different type of country is found east of Kot Jubo, Khairpur State, where the amount of sand is so great as to cover the whole face of the country in two deep sand plateaux, the Pur Chandar and Sano-i *dra-ins*. Hollows in the plateaux rather deeper than usual are filled with vegetation. Still deeper hollows form dhands.

The parts of Sind under consideration in the *Memoir* are usually described as desert, but have an appreciable rainfall of some 6 in. per annum. Much of the rain is evaporated, but some sinks down through the sand to the alluvial clay bottom and forms springs (*sims*) where the talis are deeper, the water collecting in the dhands.

The percolating water becomes heavily charged with sodium salts from the soil mentioned above, and brings them to the dhands which are consequently getting salter. The dhands are mostly shallow, although sometimes of large area ; one a mile in length may be only 10 ft. deep. In shape they are elongated ellipses, whose axes are parallel to the main bhits, *i.e.* to the direction of the monsoon winds.

In Khairpur State dhands are found on both sides of the Nara canal at distances of from ½ to 7 miles. Those at a little distance from it are highly charged with salts ; those nearer are often fresh, owing to percolation from the canal, and are easily recognised by the presence of reeds and swarms of crocodiles. Some of the former dhands are alkaline and some saline. Around the margin of the latter, tamarisk plants are found growing, and when floods occur these become submerged and eventually become covered with crystals of gypsum. Finally, conspicuous rounded hillocks (*chiroli* mounds), covered with rounded knobs, are left standing after evaporation of the water.

The alkaline dhands support a more luxuriant vegeta-

tion than the saline, and also have a peculiar smell, whilst the water is reddish in colour. The dhands are fullest after the monsoon rains. Those of small size dry up; the larger ones are not sufficiently reduced in size by evaporation to allow of concentration of salts. Only those of medium size and shallow depth are the producers of salts by evaporation around their margins.

In the Kot Jubo region the dhands are mostly alkaline; a few are saline and a few fresh. The two large plateaux of sand form reservoirs of a kind for the absorption of rain. Sometimes fresh water is found at the bottom of the deeper depressions (*kochurs*).

In the season 1918–19 there were 50 dhands in the Nara region of Khairpur, both east and west of the canal, 20 producing salts, 25 dry, and 5 containing excessive water. In addition there were 18 which had never produced any salts.

In the Kot Jubo region the dhands consist of those lying between the two sand plateaux, and those lying on their outer margins. In the season 1918–19 there were 10 producing dhands, 15 dry, and 21 containing excessive water, whilst 15 in addition had never produced salts.

In the Nawabshah or Nasrat taluqa of the Nawabshah district the dhands lie to the north of the Jamrao Canal. Owing to the embankment of the canal, and to the consequent control of flood waters, the region has been gradually drying up. Out of 27 dhands only three were producing salts in 1918–19, and there is little hope of expanding the soda production in the district.

The area containing the dhands of Thar and Parkar has been greatly desiccated since the canalisation of the Nara, so that most of the dhands that were worked for soda before 1899 are now dried up.

A large number of field analyses of bitterns and of salts produced gave great ranges of composition as shown in the following tables:

Analyses of Kalar (Efflorescence) from Sind Alkaline Dhands

	Per cent.
Sodium carbonate	1·5–16·6
Sodium bicarbonate	4·2–18·5
Sodium chloride	2·6–28·4
Sodium sulphate	3·7–42·5

These figures are only approximate, as the acid radicles alone were determined, and the amounts combined with sodium on the assumption that it was the only base present, whereas a small amount of potassium is also present.

Analyses and Specific Gravities of Bittern in Sind Dhands

(Grams per litre)

	Khairpur State.			Nawabshah District.	Thar and Parkar District.
	West of Nara.	East of Nara.	East of Kot Jubo.		
Carbonate, expressed as CO_2	5·10–55·00	8·18–58·96	1·89–50·60	2·90–17·82	2·49–23·32
Chloride, expressed as Cl	2·13–90·35	3·55–56·09	1·20–54·85	2·84–17·13	6·21–43·49
Sulphate, expressed as SO_4	1·41–37·40	2·89–32·05	0·12–23·64	2·47–17·45	3·89–47·83
Total solids	21.36–201·96	30·1–233·9	6.36–207·7	14·42–70·04	21·32–195·78
Specific gravity	1·024–1·224	1·031–1·191	1·009–1·172	1·016–1·069	1·021–1·154

Analyses of Specimens of Chaniho (Natural Soda) from Sind Dhands

(18 samples from 14 dhands)

	Per cent.
Sodium carbonate	19·9–53·5
Sodium bicarbonate	1·3–33·6
Sodium chloride	1·2–15·4
Sodium sulphate	0·2–76·0

In connection with the theory that the formation of some of the sodium sulphate is due to bacterial action, it is pointed out in the *Memoir* that (1) the alkaline dhands derive their water supply invariably from springs (sims) or percolating water coming from beneath the desert sands; (2) the soil associated with this water is of a very dark colour, and has a carbonaceous appearance; (3) alkaline dhands have a peculiar and offensive smell, differing thus markedly from the saline dhands; and (4) they contain bacteria of a peculiar type, which were found living even in strong bitterns of high specific gravity. The bacteria are anærobic, and have not been identified with any known type.

The output of chaniho (the crude salt) during the years 1912–17 in the only two districts of Sind now producing was as follows:

	Season.	Long Tons.
Khairpur State	1912–13	772
	1913–14	297
	1914–15	572
	1915–16	1,216
" "	1916–17	778
Nawabshah district	1915–16	375
	1916–17	175

The product is almost all sent away to Karachi and Sukkur, but the purest varieties are sent to Bombay. It is used for (1) washing clothes and in dyeing; (2) hardening

treacle; (3) producing molasses from sugar cane; (4) flavouring the preparation from tobacco known as *goorakko*; (5) but principally as baking powder in the preparation of *papars* or pulse biscuits.

The following are percentage analyses of the different grades of chaniho sold in the Hyderabad Bazaar:

Grade.	Carbonate (expressed as CO_2)	Sodium carbonate (Na_2CO_3).	Sodium bicarbonate ($NaHCO_3$)	Chlorine (Cl)	Sodium chloride (NaCl)	Residue insoluble in water.
I . .	31·5	68·4	11·8	1·45	2·4	6·52
II . .	36·0	84·5	3·4	1·19	2·0	3·40
III . .	23·4	56·2	0·4	13·70	22·6	5·40
IV . .	30·9	74·2	0·4	2·84	4·7	3·92

No. I. grade realised R3·12 to 4·00 per maund (82⅐ lb.); No. II. R.2·10; No. III., R.2·4 to 2·6.

The chaniho is removed from the margins of the dhands in May and June when the dhands are driest. Should abundant rains fall in July, no more chaniho is collected that season; with only scanty rain in July, a second crop is gathered in September and October.

It is not possible to make an estimate of the tonnage of salts available, but some dhands may contain as much as 25,000 tons.

Mineral Resources of Bulgaria.—An interesting summary of information relating to the mineral resources of Bulgaria is given in *The Mining Magazine* (1924, **30**, 73) by D. A. Wray, who visited the principal mining areas last year. Particulars relating to the chief minerals are given below.

Coal.—Within the last ten years the output of coal has been more than doubled, and now exceeds a million tons per annum. Anthracitic coal is worked on a small scale in north-western Bulgaria, but the ash-content is high. Bituminous coals of Liassic age are also worked on a small scale in the same region, but the chief bituminous area is in the Central Balkan range, north of Kazanlik and Sliven, extending in an E.–W. direction for fifty miles. The beds are of Upper Cretaceous age and are strongly folded in an E.–W. system of anticlines and synclines, the seams, as a rule, being steeply inclined. The coal is of a friable nature, but is an excellent coking coal, and will produce high-grade briquettes. Several of the mines are being worked on a moderate scale.

Bulgaria is comparatively rich in lignites of Tertiary age. The principal mines, viz. those at Pernik and Bobov-dol, west of Sofia, are worked by the State. The Pernik coal, which is largely used on the State railways, is liable

to spontaneous combustion. The output from this mine in 1923 was about 80,000 tons monthly.

Other lignite seams occur on the southern slopes of the Balkan range between Kazanlik and Sliven, and at Tchermo More, eight miles north of Bourgas. Tertiary lignites are also being mined on a small scale near Lom-Palanka, in northern Bulgaria, and near Kara Alti in southern Bulgaria.

Iron.—The iron ore deposits of Bulgaria are of small extent, but they contain ore of good quality, and are probably sufficient to supply the local needs of iron and steel for many years. In Eastern Rumelia, south of Yamboli, a magnetite ore deposit occurs in the form of lenticular masses in syenite. The principal part of this deposit is known as the Blagovest concession, and four samples of ore obtained by H. Kilburn Scott from it in 1910 assayed from 60·94 to 63·93 per cent. of iron ; 0·37 to 0·55 per cent. of manganese ; 0·76 to 1·62 per cent. of silica, and 0·006 to 0·030 per cent. of phosphorus.

Another magnetite ore deposit is found at Samakoff in the upper Isker Valley, twenty-seven miles S.E.E. of Sofia, consisting of magnetite segregations of no great size in syenite. Where the syenite has become disintegrated by weathering, the magnetite has been concentrated by mountain streams into pockets which furnished ore for the primitive smelting of iron in ancient times. Accumulations of slags from these former operations, estimated to amount to over a million tons, contain over 50 per cent. of iron. Similar, but smaller, deposits of the same kind are found on the northern slopes of Stara Planina ; in the neighbourhood of Kustendil ; at Kavakli, twenty-four miles north of Svilengrad ; and at several places in the Rila and Rhodope Mountains.

Hæmatite ore deposits are found near Kreminovsi and Bresnik, ten miles north-east, and twenty-two miles west of Sofia respectively. The first occurs as irregular masses in Jurassic limestones and marls, and the ore is stated to have an iron content as high as 60 per cent.

The Bresnik deposit is similar in character, with an average iron content of 52·3 per cent. and an estimated ore tonnage exceeding one million.

Magnetite sands with a high iron content, and low in phosphorus and silica are found in the coastal district of Bourgas.

Manganese.—The deposits of manganese ore, while not yielding ore of the highest grade, are of some importance for a local iron and steel industry ; they are briefly referred to in the Imperial Institute Monograph, *Manganese*

Ores (p. 71). The deposits occur in three districts, near Sofia, Yamboli, and Varna respectively. The first, known as the Pobeda concession, consists of irregular layers or lenses of pyrolusite ore up to 14 ft. thick, in Cretaceous limestones near intrusive volcanic rocks. The ore contains from 35 to 40 per cent. of pyrolusite, and during the Great War the deposit furnished about 2,500 tons of ore per month, which was used in the Rhenish Westphalian iron furnaces.

The deposit near Yamboli, known as the Dobra Nadejda concession, is two miles N.W. of Yamboli station. The ore-body consists mainly of pyrolusite, and occurs at the contact of Cretaceous limestone and Tertiary andesites. The deposit takes an irregular vein-shaped form with a maximum thickness of about 4 ft. Samples have shown a manganese content up to 45 per cent., but the percentage of silica is high.

Near the villages of Bela and Abdikeni on the western shores of the Black Sea near Cape Kara Bornu, is a manganese ore deposit, which has been mined on a small scale. The ore is present in thin lenses consisting mainly of a fairly pure pyrolusite, and impregnations of wad, in Upper Tertiary sandstones. These beds cover a considerable area, and reach a thickness of 30 ft. in places, of which, however, only about one-tenth can be regarded as ore. An official analysis of this ore gives the manganese content as 35·88 per cent., but it can be increased to about 40 per cent. by calcining the ore to eliminate moisture and water of hydration. Other constituents are iron, 7·56 per cent.; silica, 5·60 per cent., and phosphorus (calculated as P_2O_5), 0·31 per cent.

Copper.—Copper ores are found in several parts of Bulgaria. The principal of these occur near Vratsa in the west of the state, and in the immediate vicinity of Bourgas on the Black Sea. A brief description of these, as well as of a smaller copper ore deposit near Belogradchik, has been given in the Imperial Institute Monograph, *Copper Ores* (p. 89).

The copper mine of Plakalnitsa, six miles S.S.W. of Vratsa, is the most important metalliferous mine in the country and during the war produced about 100 tons of ore daily. The ore-body occurs in several irregular veins in massive Triassic dolomitic limestones, the three principal veins being now worked. The minerals present in order of abundance are erubescite, tetrahedrite, malachite, and copper pyrites, with small quantities of galena in the lower workings. The average copper content of the ore mined is about 7 per cent.

According to Wray, the old Sedmolchi-Lenitsa mine, about six miles west of Vratsa, where there are extensive primitive workings, contains copper minerals, although these are subordinate in importance to the associated lead and zinc minerals. It is suggested that this mine might repay further investigation.

At the Kara Bair mine on the southern shore of Lake Bourgas are ore veins in andesite up to 6 ft. in thickness. These consist of a siliceous matrix mineralised with the copper minerals, erubescite, chalcopyrite, malachite, and azurite; and also galena, blende, and pyrite. The mine has been exploited intermittently but apparently without much success.

About seven miles north of Stara Zagora occur irregular veins in Triassic dolomitic limestone in which the copper minerals are chalcocite, chalcopyrite, malachite, and azurite. Some intermittent mining has also been carried on at this place.

A small copper ore deposit has been reported near Vidin on the River Danube in Northern Bulgaria.

Lead-Zinc.—Generally speaking the occurrences of lead-zinc ore in Bulgaria are not important, and in some cases they are associated with copper minerals, as in the Plakalnitsa, Sedmolchi-Lenitsa, and Kara Bair mines mentioned above.

In the Lower Isker Valley, twelve miles S.W. of Vratsa, is the Lakatnik mine yielding lead-zinc ore with some associated copper mineral, and twelve miles west is the Theodoroff lead-zinc mine of a similar character. Lead ores have been reported from other localities near Sofia, some of which have been mined in past years.

Lakavitsa, twenty-four miles south of Philippopolis in Southern Bulgaria, is a very old lead-mining area, in which argentiferous galena and blende are found in veins in crystalline limestones. Other old lead-mining centres are at Srebro in the Rhodope Mountains ; and at Lerin, Libjahovo, and Degrovo in S.W. Bulgaria, near Nevrokop in the Upper Mesta Valley.

Other Minerals.—Chromite in small quantities occurs in numerous localities, and between Sotir and Ferdinand in N.W. Bulgaria, large masses have been found in serpentine.

Alluvial gold in small amount is found in several mountain streams.

Iron pyrites and arsenical pyrites occur chiefly in the neighbourhood of Bourgas.

Asbestos in some quantity has been reported at Ichtiman about thirty-two miles S.E. of Sofia.

China-clay is found and worked at three places in Northern Bulgaria; and gypsum at Jassen, and near Stara Zagora.

Rock salt mining is a long-established industry on the Bay of Bourgas and the annual production is about 30,000 tons.

Oil shale deposits of considerable extent and richness occur in the Bresnik neighbourhood and also in the vicinity of Kazanlik.

Building stone of good quality is found and worked in several parts of the State; and excellent material for cement-making is found and utilised at various places.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.*

AGRICULTURE

FOODSTUFFS

Cocoa.—The vegetative propagation of the cocoa tree is discussed by Prof. Harland in an article entitled, "The Yield of Budded Cacao" (*Trop. Agriculture, West Indies*, 1924, **1**, 66). Although it has been known for thirty years that this method of reproduction is applicable to cocoa, the area of budded trees under cultivation remains extremely small. The author gives a preliminary report of budding experiments carried out from 1914 onwards by the Trinidad Department of Agriculture at River Estate. The results indicate that there is no tendency for high-yielding trees to produce budded offspring of high productivity, and that the value of a tree for budding purposes can only be assessed by the mean yield of its budded offspring. Further, the author considers that it has been proved that certain trees, high-bearing in themselves, produce budded offspring of low-yielding capacity, and that this tendency is inherent and not due to environmental conditions. Environment exerts an influence, but the primary cause of high yield in cocoa is physiological. The writer refers to his previous work in conjunction with R. Parga, which showed that while a productive tree can

be induced to set a great many young pods by artificially fertilising the flowers, it is impossible to make an unproductive tree set fruit, however great the number of flowers pollinated. Thus, a tree is either a "good setter" or a "bad setter." Therefore, when a bud from a good setter is grafted on to another stock it seems likely that the latter influences the setting of the fruit. Harland is inclined to regard the physiological condition of the stock and the type of root system it produces as the predominating influence in the setting of fruit, and to consider that the ultimate yield of a budded tree may be viewed as a result of the interaction of the setting capacity of the stock and that of the scion.

A paper on "The Fermentation of Cacao" by A. W. Knapp appears in *Chemistry and Industry* (1924, **43**, 402, 431). The author reviews the existing knowledge relating to this subject, discussing the various details of fermentation and other methods of preparation, and supplies data from his own experiments.

Siamese Tea.—*The Record* (July, 1923) English edition, No. 9, p. 16, contains a report on the cultivation of "miang" or Siamese tea, which is of the same species as China and Assam tea, viz. *Camellia Thea*. The Siamese tea plant has, however, certain varietal differences which distinguish it from China tea, chief among them being the large size to which it grows, and its larger leaves; it is much more closely related to Assam tea. Whereas the tea plant, subject to intense cultivation, has generally given rise to numbers of varieties, the Siamese tea plant, grown under almost wild conditions, has probably not shown much variation. The plant is found wild over a wide area extending from Upper Assam through Yunnan to Tonkin. In Siam the cultivation of "miang" seems to be wholly confined to the portion of the country north of latitude 18°. In some districts the "miang" is never planted, but when the trees are found in the forest a clearing is made round them. In districts where there are large "miang" gardens, the plant is grown from seed. The only care the trees receive is the cutting of the weeds and undergrowth around them about twice a year. The four recognised seasons for picking are June, August, October and December, and the picker removes about two-thirds of a leaf, leaving the basal portion attached to its stalk. In this way four or five terminal leaves of each twig are picked.

The preparation of "miang" consists of steaming the

leaves for two hours, tightly pressing the cooled leaves into a container such as a bamboo joint or basket, and leaving the closed package for about a month, when fermentation is complete and the product is ready for use. The material is employed as a stimulant, being chewed and not used in the form of an infusion. The demand for "miang" exists only in Siam and to a small extent in Burma, and there is never likely to be any extension of the trade. There seems, however, to be no reason why, with proper methods, good tea should not be produced in the "miang" districts, and in almost unlimited quantities.

Wheat.—A review of the work done in connection with wheat by the plant-breeding branch of the Agricultural Department, Kenya Colony, appears in *The Farmers' Journ.* (1924, **6**, 5). It is considered that the Colony is capable of growing in quantity all the different qualities of grain required to blend into a good bread-making flour to replace imported materials. Difficulty has been experienced owing to the destruction of crops by various rusts, and to the fact that practically all the varieties of wheat growing in the Colony in 1921 were mixed and unsatisfactory in quality. Considerable progress has now been made in selection work and the growing of newly imported varieties with a view to obtaining rust-resistant strains suitable for different localities.

Rice.—In certain parts of India the natives steep the unhusked rice (paddy) in water for a varying length of time, up to about four days, subsequently steaming it and drying it in the sun. The paddy is then milled in the usual way, and according to the thoroughness of steeping and steaming it is found that the rice has been gelatinised and is practically translucent. This parboiled rice, as it is called, is believed by the natives to be more sustaining than ordinary white rice, and there is also much less breakage in milling.

The obnoxious odours emanating from the steeping tanks and steaming plant during the parboiling of the rice have become a serious nuisance in Burma. Investigations carried out by J. Charlton, the Agricultural Chemist, have traced the cause of the nuisance to putrefactive bacteria in the steeping tanks, and have resulted in a new method of steeping being devised (*Bulletin*, No. 146, 1923, *Agric. Res. Inst., Pusa*). The foul odours can be prevented either by acidification of the steeping water or by steeping at temperatures initially not lower than 60° C. at the coldest portion of the tank. The

latter method, avoiding the use of acid, is preferable, and incidentally cuts down the time required for steeping to one-third or less of that required by the old method, thus increasing the output from a given number of tanks. The colour of the parboiled rice obtained by the process, particularly when the steeping does not exceed twenty-four hours, is the best attainable in practice, and the breakage during milling is not increased. The results of the work also indicate that (1) anaerobic bacteria are chiefly responsible for the nuisance; (2) germination of paddy in the steeping tanks is encouraged by low acidity and aeration; (3) breakage in milling of parboiled rice is chiefly due to too rapid drying; and (4) faulty colour occurs after too protracted steeping or after steeping at too high a temperature.

A report on the rice crop of Siam for the year 1922–23 is given in *The Record* (October, 1923, English edition, No. 10, p. 41). Details are given of area planted and of damage by floods, crabs, etc., and yields are recorded for the seven Circles which supply by far the greater bulk of the rice for export. The total area harvested in the year under review was 3,468,000 acres, which yielded 2,376,600 tons of paddy as compared with 2,365,700 tons from 3,568,000 acres in the previous year, there thus being a slight increase in the yield per acre.

Sugar.—The *Colonial Office Report on Jamaica*, 1922 (*Ann. Ser.* No. 1190, p. 13), records an improvement in the sugar industry in the island. The exports of sugar amounted to 50,000 tons, or double those of 1921, and although prices were for the most part low they improved considerably towards the end of the season, and have subsequently risen still higher. Despite the large production in 1922 most of the estates made but small profits, and in some cases showed a deficit on the year's working. In view of the higher prices now ruling the outlook for the industry is more promising. The policy of the Government in granting assistance when values underwent a sensational fall in 1921 appears to have been fully justified by the results.

Oils and Oil Seeds

The Vegetable Oil Industry of South Africa.—The possibility of expanding the vegetable oil industry in South Africa is discussed in a recent number of the *South African Journal of Industries* (1924, 7, 171). Already the whale oil industry has assumed considerable proportions,

and the development of fisheries is receiving close attention. The soap industry has been firmly established and South Africa is self-supporting in this respect. With regard, however, to edible and lubricating oils the position is very different, there being only two or three factories engaged in the production of such oils.

The conclusion is reached that the oil seeds worthy of attention and likely to be of commercial importance in South Africa are ground nuts, cotton seed, maize, soy beans and possibly castor seed.

Babassu Nuts.—Babassu nuts have only been exploited in Maranhão, Brazil, on a large scale since 1915, but by 1920 the value of the exports of the nuts had reached 3½ million milreis[1] while in 1922 the figure had increased still further. The present demand is stated to be greater than the amount the producers can furnish (*Bull. Mat. Grasses*, 1923, Nos. 11 and 12, p. 428). At first the oil was only used for the manufacture of soap, but later it was employed as an edible material. The greater part of the state of Maranhão in the vicinity of the town of San Luiz is covered with forests of babassu palms which grow readily near streams and rivers. Only a relatively small proportion of the vast quantities of nuts available has so far been exploited owing to the lack of a rapid method of cracking them. By the present method of breaking the nuts open with an axe the maximum quantity that one worker can produce is 11 lb. of kernels per day. Each babassu palm yields on an average three or four heads twice a year, each head containing from 250 to 300 nuts. A single head weighs from 330 to 440 lb., so that each palm produces about 1 ton of nuts per annum, representing about 270 lb. of kernels. In order to develop the industry it is recommended that a fixed price should be paid for the nuts delivered at various places in the State, the nuts being then transported to San Luiz. This method would have the great advantage that men, women and children could all be employed in the collection of the nuts, whereas at present the work is done by men only, who break the nuts in the forests and bring only the kernels to the villages for sale. According to the proposed scheme the nuts would be shelled at San Luiz and the shells might be used as fuel on the railway or converted into coke for use in smelting the local deposits of manganese ore. An article on the uses of babassu kernels and the nature and use of the fat appeared in this BULLETIN (1917, 15, 38).

[1] The average rate of exchange in 1920 was about 14*d*., so that the approximate value of the exports in sterling was £200,000.

——.—As individual coconut palms vary considerably in the yield of nuts, it is to be expected that plantations grown from selected palms which regularly give high yields will be more profitable than plantations established with but little care and without proper selection. Preliminary investigations from this point of view have been recently started at Jaela, Ceylon, on certain varieties of coconut palms (*Trop. Agric., Ceylon*, 1924, **62**, 204). For this purpose nineteen types of palm have been selected, differing from one another in respect of the external features and the shape and size of the nuts. Data will be collected as to the yield of nuts and copra from each type and it is hoped that as a result it will be shown whether desirable nuts of good copra-producing qualities can be recognised by their size, shape or colour. At the present time, the yield of copra is not considered to be proportional to the size of the nuts and, although manufacturers of copra prefer the rounder to the longer nuts for their purpose, observations have so far not borne out the supposition that the rounder nuts produce more copra than the longer ones.

Illipe Nuts.—C. D. V. Georgi, in an article in the *Malayan Agric. Journ.* (1924, **12**, 77), deals with the Illipe nuts of commerce and gives the results of examination of the fat (Borneo tallow) obtained from several varieties of the kernels. The results are of interest in relation to those obtained some years ago at the Imperial Institute (see this BULLETIN, 1915, **13**, 335). The collection of the nuts in Malaya, Borneo, Sumatra and Java is a native industry. There are no plantations, and it does not appear likely that any attempts will be made in this direction, as the trees take several years to come into bearing while the yield is variable. A large proportion of the trade in Illipe kernels passes through Singapore, from which port 146,033 piculs (8,692 tons), valued at about £218,560, were exported in the first half of 1923.

The results obtained by Georgi show that the percentage of fat in the various samples varies considerably even among those that otherwise differ only in colour, as in the case of the large brown and large black Pontianak nuts. The analytical data for the different fats all fall within very narrow limits with the exception of the acidity, and, in the case of small Siak nuts, with that of the percentage of unsaponifiable matter (6·4). The figures are interesting, but their value would have been greatly increased if the examination had been carried out on more than one sample of each variety.

Oil Palm.—In the early part of 1922 a study of the native methods of extraction of palm oil was started by the Agricultural Department of Nigeria. The chief object of this work was to determine which of the many variations of this process was the best and to discover whether there was any economic reason why this best method should not be introduced universally throughout the Colony. The two methods in general use in Nigeria are the Soft Oil process and the Hard Oil process. The former process, which is practised in the district round Lagos, is described as follows in the *Second Ann. Bull., Agric. Dept., Nigeria* (1923, p. 3). The heads of fruit are cut up into small clusters of fruits and the central woody axis removed. These clusters are stored for from 2 to 4 days in order to loosen the fruits from their stalks. The fruits are then picked out by hand and boiled with water in large pots until soft. The next day they are pounded in a mortar to loosen the pulp from the nuts. The crushed mass is transferred to a pit half full of water and the pulp worked by hand, whereby the oil is liberated and rises to the surface. The scum is removed and boiled, when the water and the suspended fibrous matter sink to the bottom leaving the oil as a clear layer on the top. This layer of oil is then "fried," that is, heated in another pot for about 15 minutes in order to drive off the last traces of water. The resulting product has an average free fatty acid content of 16 per cent., though with care this may be reduced to about 5 per cent. It will be seen from this description that the salient features of the process are that the oil is prepared from comparatively fresh fruits, very little fermentation having taken place during the few days of storage; the fruits are boiled before being depericarped, thereby checking any subsequent deterioration through the action of enzymes; and the last traces of water are removed from the oil so that the formation of free fatty acids by hydrolysis is prevented.

The Hard Oil process is practised in the Sapele district of Nigeria, and the following are the essential details of the process: the heads of fruit after harvesting are stored under cover for from 7 to 14 days to loosen the fruits from the stalks. This prolonged storage does not appear to increase the acidity of the resulting oil to any appreciable extent. The heads are then taken and given a few sharp blows with a stick, when the ripe fruits fall out, any unripe or over-ripe ones being rejected. The fruits are separated from the chaff and other rubbish by riddling through mats, made from the mid-ribs of palm leaves. The sifted fruit is then transferred to a trough or "dummy

canoe" at the water-side. This canoe has a dug-out "keel" about 8 in. across, the sides being made of split logs caulked with fibre and the ends wattled. The whole canoe measures from 12 to 14 ft. long, from 2½ to 3 ft. deep, and is 3 ft. across at the top narrowing down to 8 in. at the bottom. The keel is sloping, one end being 9 in. higher than the other. An awning of palm leaves, at a sufficient height to allow a man to stand upright in the canoe beneath it, acts as a protection from the weather. At the lower end of this canoe the fruit is piled, sprinkled with water at the rate of about half a gallon per 100 lb., carefully covered with leaves and mats and left overnight. The next morning the fruit is mashed by treading it with the feet, and the pulp, which has been softened by the night's fermentation, is separated from the nuts. After mashing, the pulped fruit is packed at the higher end of the canoe, while a 3-in. channel is made at the bottom of the pile. This mass is covered and left overnight. In the morning a quantity of oil is found to have collected at the lower end of the canoe, the pulp by this time having reached a temperature of over 50° C. and the heat of the fermentation having been sufficient to liberate the oil. The oil is a thick, claret-coloured liquid, containing no water, and is given no further treatment. Warm water is now sprinkled on the pile of fruit at the rate of about one quart per 100 lb. Mashing is repeated, the pulped mass piled again at the higher end of the canoe, covered and left overnight. Next morning more oil is found at the lower end, but only about half as much in quantity. This portion is added to the first runnings. The remainder of the oil is extracted from the pulped mass in two stages by the use of more water. In the first stage about 1½ gallons of hot water are added to the top of the pile, and in percolating through the mass the water carries with it oil that had not previously drained away through the channel. This oil collects on the surface of the water at the lower end of the canoe and is removed by skimming. This separated oil is then "fried" to remove the last traces of moisture.

The pulp, however, still contains a considerable quantity of oil that has not been freed by fermentation and pressure. This residual pulp in 200 lb. lots is shovelled to the lower end of the canoe and 40 gallons of water are added in 10 gallons at a time, a small quantity of fibre also being incorporated. The pulp is then worked by hand as in the Soft Oil process, and a similar yellow scum rises to the surface. This scum is skimmed off, boiled, stirred and poured through a double strainer of mats into

a shallow iron pan. As the oil contains practically no water it is not "fried." In comparison with the Soft Oil process there is a considerable saving of labour and of wood fuel in the case of the process just described. By the latter method a yield of 10 per cent. of oil on the weight of fruit extracted is obtained, while by the former process only 8 per cent. of oil is produced. The computation of the relative cost of the production of one ton of soft oil and of hard oil in terms of money presents such great difficulties that the presentation of the relative costs is best given in terms of time taken. Estimated on these lines it is calculated that it takes about three times as much labour to produce one ton of soft oil as to produce one ton of hard oil. In spite, however, of the higher cost of production, the producer of soft oil does not appear to receive any premium on account of this oil containing less free fatty acids. The Soft Oil process, though giving a better oil, is not likely to replace the other process on account of the increased amount of labour required. Therefore future investigations of the Agricultural Department will be concerned with the introduction of improvements in the various extraction operations. One of the chief difficulties that will be encountered will be in obtaining an increased price for oil of improved quality which will be proportional to the increase in the cost of production.

The question of the erection of central factories in Nigeria is also discussed in the *Second Annual Bulletin* (p. 14), but the conclusion arrived at is that, at present, it would be a most difficult subject on which to offer advice.

Salvia plebeia.—This small shrub occurs throughout India in the plains as well as in the hills up to 5,000 ft. high. The seeds have been found by Rau and Simonsen to contain 11 per cent. of a semi-drying oil with the following constants: specific gravity at 30/30° C. 0·934; saponification value 195·0; iodine value 131·1 per cent., and titre, 10·5–11° C. The oil was found to contain the glycerides of stearic, oleic, linolic and linolenic acids (*Indian Forest Records*, 1924, **10**, 15).

The oil from another species of *Salvia* (viz. *S. hispanica*) from Mexico was examined a few years ago by Gardner, who found it to be a drying oil with an iodine value of 196·3 per cent. (see this BULLETIN, 1920, **18**, 558).

Telfairia pedata.—The seeds of *Telfairia pedata* were examined some years ago at the Imperial Institute and found to give a good yield of oil, which could be employed for soap-making but was unsuitable for use as an edible

oil owing to the presence in the husks of an intensely bitter substance, which also renders the cake unsuitable for feeding purposes (see this BULLETIN, 1912, **10**, 223). In a paper published in *L'Agron. Col.* (1924, **10**, 78), P. de Sornay advocates the cultivation of the plant in Equatorial Africa. The regular cultivation of the plant does not appear to have been tried hitherto. The seeds, if planted at the beginning of the rainy season, germinate rapidly, and the young plants can be transplanted when from 50 to 60 cm. high. Fruits are produced at the end of two years, and the plants continue to bear for several years according to the nature of the soil. In poor soils the plants generally die at the end of three years. Each liane produces from 40 to 50 fruits. If the husks were removed before the oil was expressed the latter might, as Sornay suggests, be used as a substitute for the better grades of olive oil, but there is at present no machine available for shelling the seeds, and shelling by hand, even with native labour, would be very expensive.

Tung Oil.—The results of an enquiry conducted by the Divisional Forest Officer, Southern Shan States Division, Burma, as to the occurrence of the "Tung" oil tree in those States are given in *Ind. For. Records* (1923, **10**, 11). It was found that the tree occurs only in the extreme north-east corner of the Division in the Mong Yawng circle of Kengtung State, and that only seventeen trees there were bearing fruit. Seeds from these trees were identified as those of *Aleurites montana.* The tree appears to be tolerant as regards locality, but grows best near water. It is found up to an altitude of 1,500 ft. and flowers in March–April. The fruits begin to ripen in August-September, but are not fully ripe until October. They are usually three-seeded, but occasionally contain four seeds. From the evidence available it is considered that the cultivation of *A. montana* in certain restricted areas of the Southern Shan States would not be difficult, but that *A. Fordii*, with its higher range of elevation, would prove more suitable for general cultivation in most of the States.

A quantity of the seeds of *A. montana* from Mong Yawng have recently been examined at the Forest Research Institute and College, Dehra Dun. The results of the examination of the oil obtained from them by extraction with cold benzene are shown in the same number of the *Indian Forest Records* in comparison with those for the oil of *A. Fordii* (from trees grown at Dehra Dun), *A. cordata* and *A. triloba*, and with the American standard

specification for Tung oil. The oil of *A. montana* was found to differ from that of *A. Fordii* and from the American specification in having a lower iodine value and in taking a longer time to polymerise. It also differs from *A. Fordii* oil in that when freshly extracted it solidifies to a crystalline fat on standing, whereas the latter is liquid. This was found to be due to the fact that *A. montana* oil consists of the glycerides of β-elæostearic, oleic and linolic acids, while Fahrion has previously shown that the oil of *A. Fordii* consists essentially of the glycerides of α-elæostearic and oleic acids.

The results of experiments conducted by Gardner in connection with the methods of crushing tung oil seeds are given in *Circular* 205, 1924, *Sci. Sect. Educ. Bur. Paint Manuf. Assoc., U.S.A.* The experiments, which were carried out on American grown seed, show that when crushing undecorticated seed an oil of pale colour, low acidity and quick polymerising power is best obtained by drying the seeds first and expressing the meats without any preliminary cooking. It was further concluded that the seeds should be crushed within a year of being harvested.

Two articles have recently appeared in *Chemische Umschau* on tung oil. The first (1924, **31**, 23) deals with the use of the oil in the manufacture of linoleum, and the other is a general article describing its chemical composition and properties (1924, **31**, 69).

RUBBER

Rubber Experiments in Madras.—The Department of Agriculture, Madras, has recently published a *Report on the Work done on the Rubber Experiment Station, Mooply,* 1922–3, by D. G. Munro. The Station is situated in the middle of a large rubber area and consists of 20 acres of rubber trees mostly planted in 1910, with a small block of less than an acre planted in 1913.

A census was taken of the yield of each tree at the Station in the months of September and November. Two hundred and thirty-four poor-yielding trees were thrown out of tapping.

There are five plots in which tapping experiments are being made, viz. (1) daily tapping on one-third section; (2) alternate day tapping one-third section; (3) alternate day tapping half section; (4) daily tapping one-third section, but tapping side changed over in October; (5) daily tapping one-third section, rested in July and

August during the monsoon. The yields from these plots so far are in the following proportions: (1) 100; (2) 73·6; (3) 89·1; (4) 96·3; (5) 106·0.

Bud-grafting.—Mr. H. C. Pinching, Senior Scientific Officer in Malaya of the Rubber Growers' Association, visited Java and Sumatra during September, October and November 1923, to enquire into the present position of bud-grafting as a means of producing fields of high-yielding trees. His report is published in the *Bulletin of the Rubber Growers' Association* (January 1924).

Over 90 per cent. of successful graftings have been obtained in certain fields, and it is estimated that the extra cost of planting an area with bud-grafted material as compared with planting seed at stake or ordinary stumps should not exceed $15 (30s.) per acre.

Bud-grafted trees grow as satisfactorily as plants from seeds. They have, however, the following characteristics: (1) the trunks have a peculiar cylindrical shape; (2) the rate of decrease in the number of laticiferous rings occurring in the vertical layers on ascending the trunk is much less than that found in trees grown from seed; (3) there is a marked similarity in the trees from one "clone" (*i.e.* raised from the buds obtained from one and the same tree). This similarity extends to (*a*) crown formation; (*b*) size and shape of leaves; (*c*) thickness and general external appearance of the bark; (*d*) distribution of laticiferous vessels, stone cells, and other tissues in the cortical layers; and (*e*) shape, marking and colouring of seeds; (4) the bark of bud-grafted trees is generally thinner than that found on seed-grown trees of a similar age. Several cases are known in which the renewal of tapped bark is poorer than that occurring on seed-grown trees in the same area.

There is no evidence to show that the junction of scion and stock in a bud-grafted tree forms a point of structural weakness. It can be stated definitely that the growth and development of bud-grafted trees for the first eight years are similar, age for age, to those of trees raised from seeds.

Conclusive results as to the latex yield from the tapping of bud-grafted trees are not yet obtainable. Mr. Pinching, however, believes that the results obtained will enable him to deduce: (1) that there is a greater similarity between the yields of bud-grafted trees of one "clone" than between the yields of trees grown from the seeds of a single mother tree or of trees grown from selected seeds; and (2) that buds taken from high-yielding trees do not

necessarily give rise to high-yielding offspring. He concludes that planting a large number of seed-selected plants per acre and the replacement of low yielders may result in as high-yielding an area as that given by planting with bud-grafted material. At present it is advisable to plant mixed bud-grafted and seed-selected plants at about 200 per acre, and then to remove the low yielders.

Tapping.—T. H. Holland, Manager of the Experiment Station, Peradeniya, Ceylon, gives an account in the *Tropical Agriculturist* (1924, 62, 195) of the yields of rubber obtained per tree up to the end of 1923 in a series of tapping experiments. The experiments include two series of comparisons of yields obtained when trees are tapped on alternate days with the yields obtained when the trees are tapped every third day. In both series the tapping cut was a single cut to the left on half the circumference. In the first series of experiments the cut commenced at 30 in. from the ground and was at an angle of 22½°. In the second series the cut commenced at 16 in. from the ground in the case of trees tapped every third day and 24 in. from the ground in the case of those tapped on alternate days. The angle of the cut in this series was 16°. In the first series of experiments for the period 1919–23 the yield from the three-day tapping system amounted to 71 per cent. of that from the two-day tapping system, whilst in the case of the second series of experiments, from April 1922—December 1923, the three-day system gave 81 per cent. of the yield of the two-day system.

Experiments are also being made to compare the effect on the yield of rubber of different methods of spacing the trees. One block of trees is planted in clumps, another in avenues and a third with equal spaces between the trees. The character of the land differs on the three blocks and the same tapper is not employed throughout. The results, therefore, are not strictly comparable. The trees planted in clumps give by far the biggest yield of rubber per tree, but not per acre.

A comparison is being made of the effect on yield of a single cut to the left at 16° with a single V-cut. In both cases the trees are tapped on a half-circumference on alternate days. The results so far do not indicate any advantage in the V-cut.

Preservation of Rubber Latex.—Much attention has recently been given in rubber-producing countries to the methods of preserving rubber latex. Reference was made in this BULLETIN (1923, 21, 393) to an article on this

subject by B. J. Eaton, Agricultural Chemist, Department of Agriculture of the Federated Malay States, and further information has now been given by T. E. H. O'Brien in *Bulletin No. 32 of the Ceylon Rubber Research Scheme*, which contains an account of a series of experiments, the principal object of which was to determine whether ammonia, which is now used for the purpose, could be replaced by some other preservative less expensive and less difficult to handle. Laboratory tests were made with caustic soda; sodium carbonate; phenol; formalin, with and without caustic soda; formalin with ammonia; sodium phenoxide; disinfectant creosote solution (phenoid); potassium cyanide; and mercuric chloride. The results, however, did not furnish sufficient evidence to prove that any of these would be satisfactory; caustic soda and sodium phenoxide gave promising results, but had disadvantages not met with in the case of ammonia.

In order to test the effect of preservatives on the quality of the rubber obtainable from the latex, samples of crêpe rubber were prepared from fresh latex and from latex containing preservatives and were hung in the drying room away from direct sunlight. The crêpe rubbers prepared from latex preserved with caustic soda and with sodium phenoxide became "tacky," whereas those made from fresh and ammonia-preserved latex did not.

With the object of determining the best proportion in which the ammonia should be introduced, tests were carried out with latices preserved with varying percentages of ammonia, and stored in kerosene tins and iron drums. Samples containing as little as 1·5 per cent. of 20 per cent. ammonia remained uncoagulated after six months. Whether kerosene tins or iron drums were used seemed to make no difference to the results. Investigations were also carried out at the Imperial Institute on the same series of samples, full particulars of which are given on page 136 of this number of the BULLETIN. A duplicate set of samples was also submitted for technical trials to Messrs. Kaye's Rubber Latex Process, Ltd., who reported that the latices containing either 3 or 5 per cent. of ammonia were equally suitable for their purpose.

A number of tests were made to determine whether the addition of very small amounts of antiseptic substances had any influence on the minimum percentages of ammonia required for preservation; but the results indicated that no important reduction in the amount of ammonia could be made.

When latex coagulates spontaneously the evolution of gas continues for several days, and in order to obtain

some indication of the consequences if latex were shipped, with an insufficient quantity of preservative, experiments were carried out to determine the pressure developed during coagulation in an enclosed space. The results showed that it would probably not be practicable to leave enough space in the receptacles to keep the pressure of the gas produced sufficiently low if the latex coagulated in transit. In practical tests with kerosene tins, the tins did not burst but split along the seams, and it is considered that for this reason no danger from explosion need be apprehended from premature coagulation if such tins were used.

In conclusion, it is recommended that, for preserving latex with ammonia, 3 gallons of strong liquid ammonia (of specific gravity 0·904 at 28° C.) should be added to 100 gallons of undiluted latex.

Tensile Strength.—De Vries discusses in the *Journ. Soc. Chem. Ind.* (1924, **43**, 50T) the importance of tensile strength determinations and the factors that should be taken into account when interpreting the results. He concludes that the breaking load of vulcanised rubber is not an important figure, because in practice the rubber is seldom stretched to that extent. He expresses the opinion that other testing methods will be developed in the future and that tensile strength determinations will only be made in special cases.

From a study of a large number of results he finds that the figures for tensile strength are influenced by the length of time the rubber is heated during vulcanisation. An increase in time of cure of about 10 per cent. causes a decrease in tensile strength of about 1 per cent.

When this correction is taken into account, the tensile strengths of sheet and crêpe rubber prepared from the same latex are found to be the same, and the tensile strength of slab rubber is not higher than that of sheet or crêpe.

Rubber prepared from latex coagulated with alum did not show any deterioration in (corrected) tensile strengths, but when excess of sulphuric acid was used a larger decrease in tensile strength occurred than that which would correspond with increased time of cure.

Special experiments were made which failed to show that a sea voyage caused any reduction in the tensile strength of the rubber.

FIBRES

Broom Corn.—An article on the cultivation in New South Wales of broom corn, or broom millet, the variety

of *Sorghum vulgare* which yields the brush-making fibre commonly known as Italian whisk, is given in *Agric. Gaz., N.S.W.* (1924, **35**, 165). Although there is a large extent of country in the State well suited to the crop, the industry has only become established in a few districts. This is due to the fact that these districts were the first to undertake the cultivation and are able to supply all the local demands for the fibre, except in adverse seasons, when manufacturers can readily import it from Italy. The chief localities in which the crop is grown are the Lower Hunter River, Tamworth, Richmond River, Manning River, and Tumut districts. The total areas devoted to broom millet and the total yields obtained during recent years were as follows :

Year.	Area. *acres.*	Production *cwts*
1917–18	1,918	9,261
1918–19	3,019	13,833
1919–20	4 220	16,703
1920–21	1,453	8,126
1921–22	1,230	8,638

The article gives an interesting, illustrated account of the soil and climatic conditions required and of the methods of cultivation, harvesting and preparing the fibre for the market.

Coir.—In the course of the preparation of copra in the Dutch East Indies millions of coconut husks are thrown away each year, and for a long time past consideration has been given to the possibility of utilising these husks as the raw material for a coir and coir yarn industry. Although all the efforts hitherto made in this direction have failed to achieve success, great interest is still taken in the question, and in view of this the Commercial Museum Department of the Colonial Institute of Amsterdam has undertaken to study the problem anew. It appeared that in the first place it would be advisable to have a thorough investigation made of the existing coir industries of Ceylon and British India, and Dr. A. J. Kluyver was therefore asked to undertake this mission, Raden Mas Iso Reksohadiprodjo, an agricultural expert, being appointed as his assistant. The results of the observations of these investigators have now been published (in Dutch) as *Mededeeling No. XX, Afdeeling Handelsmuseum No. 5, Koloniaal Instituut te Amsterdam.*

The report gives an account of coconut cultivation in Ceylon and of the different types of coconut palms grown in the island ; it describes the methods employed in retting the husks and extracting the fibre, and deals

fully with the spinning of coir yarns and the preparation of brush or bristle fibre for the market. Information is supplied regarding the cost of production and the value of the products. The coir industry of the Malabar Coast is similarly dealt with and also that of the Maldives and Laccadives.

The work is undoubtedly the best description of these industries hitherto published, and is well illustrated with a large number of excellent photographs. Interesting information is given relating to the processes of retting, and it appears that these must be varied to meet the requirements of husks derived from different types of coconut palms, the degree of ripeness of the nuts and the local conditions.

Recommendations are made with regard to experiments which should be carried out in the Dutch East Indies, and the possibilities of the creation of a coir, coir yarn and bristle fibre industry are discussed. Emphasis is laid on the fact that, in order to develop a remunerative industry, endeavours must be made to obtain products of the highest quality.

Cotton

Nigeria.—In the *Annual Report of the Agric. Dept., Nigeria, for* 1923, reference is made to the progress of the cotton-growing industry. In the Northern Circle, *i.e.* the provinces of Sokoto, Kano and Zaria, the production of cotton from American seed has steadily increased, as shown by the following exports (expressed in bales of 400 lb. of lint):

Year	1915-16.	1916-17.	1917-18.	1918-19.	1919-20	1920-21.	1921-22.	1922-23.
No of bales .	121	433	855	2,248	3,568	5,405	9,303	10,774

Of the exports for 1922–23, 53 per cent. was classed as first grade. During the current season (1923–24) the exports are expected to amount to 15,000 bales, of local value of over £300,000, or £75,000 more than the local value of the same quantity of the indigenous cotton. The quantities of native cotton purchased in 1921–22 and 1922–23 were 35 bales and 1½ bales respectively.

A system of grading the cotton which was introduced in 1922 and the improved supervision of the markets rendered possible by an increase in the staff of European officers have resulted in a considerable improvement in the care taken in picking the cotton. The grading is popular with the growers and has encouraged them to extend the cultivation. The prospects for the next season are very good, but the time is approaching when

further extension will not be possible in the absence of improved means of transport and the establishment of ginneries at some distance from Zaria, as at present all the seed-cotton has to be conveyed to Zaria by means of pack animals.

The results in the Middle Belt are less satisfactory, but this is due to the fact that until the present season the necessary staff has not been available for carrying out the extension work efficiently. The production in 1923–24, however, is expected to show a large increase. The purchases of American cotton (in 400 lb. bales) in the Middle Belt during 1921–22 and 1922–23 are given in the following table :

	1921-22. bales.	1922-23. bales.
Nassarawa (Abuja District only) .	180	27 (29 per cent. of Grade I)
Nupe	417	373 (28 " " ")
Ilorin	74	79 (16 " " ")

The purchases of native cotton were 785 bales in 1921–22 and 1,179 bales in 1922–23, the increase in the latter year being mainly due to purchases in Munshi, Muri, Kabba and Yola.

In the Southern Circle all the efforts made for nearly twenty years to establish the cultivation of American cotton have been unsuccessful, whilst the export of the indigenous cotton has shown no appreciable change, having amounted to 5,000–10,000 bales per annum, according to the prices offered. The causes which have militated against the production of American varieties are now being carefully investigated by the recently increased staff of the Agricultural Department, and it is hoped that definite and reliable conclusions will shortly be reached which will provide accurate information as to whether there is any real prospect of evolving an improved commercial cotton for Southern Nigeria, and, if so, the lines on which success may be achieved.

Colombia.—Reference to cotton-growing in Colombia was made in this BULLETIN (1921, **19**, 18), and a fuller account of the industry has now been given by Dr. J. Medina, of the Colombian Bureau of Information in London, in the *International Review of the Science and Practice of Agriculture* (1924, New Series, vol. ii, page 27). Hitherto cotton has been grown only by individual planters, but it is considered that the industry could be readily developed by means of capital as large tracts of suitable Government land are available and cheap labour can be obtained.

Five zones are mentioned as offering good prospects for the cultivation. The first zone is on the Atlantic

Coast, and includes the lands beyond the rivers Magdalena, Sinu and San Jorge, where the conditions are very favourable. The temperature for a considerable distance inland varies between 90° and 100° F. during the whole year. The rainfall is regular and seasonal, the soil is suitable, and facilities for river transport are constantly improving. About 75 per cent. of the cotton crop is at present produced in this area. The second zone is also on the Atlantic Coast and is situated on the Goajira, and it is in this region that the best type of cotton is produced. The third zone comprises the land between Puerto Berrio and Neiva, along the Magdalena Valley, and includes the Departments of Antioquia, Santander, Tolima, Huila and a portion of Boyaca and Cundinamarca. In this part of the country the temperature throughout the year varies between 70° and 90° F. and the rainfall is satisfactory. The fourth zone covers the Santander, Boyaca, and Cundinamarca Departments, where cotton is already grown, especially along the Suarez, Chichamocha, Upia, Legupa and other rivers. The East Llanos or Plains also possess suitable areas where one of the best types of indigenous cotton is found. Samples of this cotton have been examined at the Imperial Institute and the results have been published in this BULLETIN (*loc. cit.*). The fifth zone occurs along the Cauca and Patia Valleys and in other districts of the Valle, Cauca, and Marino Departments on the Pacific Coast.

The cotton produced in Colombia is grown in a very primitive manner. The land is merely lightly cleaned before sowing, and subsequently receives but little attention. The plants are usually left in the ground for several years, being sometimes cut down to about 9–12 in. from the ground at the close of the picking season.

The crop nearly always contains a small percentage of brown cotton. The cotton is fine and varies in length from 1 in. to $1\frac{5}{16}$ in. A number of indigenous varieties are described by Dr. Medina, and it is stated that the introduction of exotic varieties has not proved successful as, in all cases, such types have sooner or later degenerated.

In 1915 it was estimated that 11,240 acres were devoted to cotton in Colombia and that the production amounted to about 7,600,000 lb. During 1923 the area under cultivation was more than twice as large and the production may be estimated as over 16 million lb. The cotton is not exported, but the whole crop is utilised locally by the cotton mills and domestic industries. There are several large mills in the country, some of which are

equipped with machinery imported from Lancashire. Approximately 1,600 looms are now in operation, with an average daily output of about 36,000 yards of fabrics.

Dahomey.—The progress of cotton growing in Dahomey is the subject of an article contributed by L. Réteaud, Director of the Agricultural Department, Dahomey, in *Revue Botanique appliquée et d'Agriculture coloniale* (March 1924, p. 209).

The cultivation of cotton in Dahomey is practised in five regions of the country in latitudes above 7° N. In the region of Abomey the crop is grown from seed obtained from Togo, where the Germans introduced the Sea Island variety. The cotton has deteriorated and has also undergone hybridisation with the native varieties of *Gossypium hirsutum*. At the present time there are to be found in the same field a few plants of *G. hirsutum*, rather more with the characters of Sea Island, and a mixture of forms which are often difficult to classify as hybrids or variations. Seeds examined in a ginnery were divided into the following groups: seeds bearing green or buff-coloured fuzz, 22 per cent.; seeds with white or grey fuzz, 50 per cent.; naked seeds, 28 per cent.

The Savalou region is the most important cotton-growing area of Dahomey, and possesses two ginning factories. The seeds were found to be divisible into the following groups: seeds covered with white or grey fuzz, 21 per cent.; seeds with green or buff-coloured fuzz, 62 per cent.; naked seeds, 17 per cent. The *G. hirsutum* type is the most common, and the hybrids approach much more nearly to this type than to Sea Island.

In the northern region, plants of *G. peruvianum* occur almost everywhere, the seeds of which bear a buff-coloured fuzz and a rather coarse cotton. In some fields plants of *G. hirsutum* are found, but Sea Island cotton is absent. In many villages there are plants of *G. arboreum*, which are cultivated for the sake of the deep wine-red flowers from which the natives prepare a black colouring-matter for dyeing leather.

In the Holli-Kétou region, the northern part produces a cotton the seeds of which are covered with greyish fuzz, whilst another kind is sometimes met with which bears a khaki-coloured lint. In the southern part of this region the cotton has the same characters as that grown in the Abomey region.

It is obvious that the cotton obtained in these various regions is of a very mixed character, and is therefore seriously lacking in regularity. Efforts are now being

made by the Department of Agriculture to effect an improvement in this respect. Smooth seeds of the Sea Island type have been selected and sown over a total area of 54 hectares, distributed through the five cotton regions. Some of the plants derived from these seeds are hybrids, whilst others present the characters of the pure Sea Island type. Selections are being made from these for further experiment. It is proposed to continue the selection from year to year and to discard all the seeds which exhibit signs of degeneration. The improved seed is supplied to growers in given centres, and these districts will be gradually freed from the mixtures of varieties now grown. A special ginnery is being erected at Parahoué in order to assist in this work. Measures have been enacted which will ensure the control of the ginneries, the control and classification of the cotton intended for export, and the uprooting and burning of the plants after the close of the picking season.

In 1923 the region of Savalou produced nearly 500 tons of seed-cotton with a ginning yield of 30·9 per cent. It is stated that during the present season the area planted with cotton in Dahomey is twice as great as that of the previous season, and that a large crop is anticipated.

French Sudan.—The possibilities of the development of cotton-growing in the French Sudan are dealt with in a paper by Pierre E. Rignault which has been published in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (1924, **136**, 147).

The French Sudan, from the banks of the Niger to the countries which extend to the south of the Bani, from Bamako to Timbuctoo, is well adapted for cotton-growing and a vast project has been put forward for the irrigation of the middle valley of the Niger with a view to the expansion of the industry. It is estimated that the scheme will cost 300 million francs and will require thirty years for its completion.

The author is of opinion that the realisation of this project would not increase the output of cotton to a sufficient extent to justify the expense, time and labour involved, and that, in present circumstances, measures are urgently needed which will ensure an increased production with as little delay as possible. An account is given of the possibilities of the different parts of the country for growing cotton either without irrigation or with pump irrigation, and it is stated that these regions could be made to yield large quantities of cotton for export if efforts were made to encourage the production of indi-

genous varieties by the natives, and especially if the agricultural authorities were to devote themselves to developing the cultivation without irrigation of selected native varieties and of quick-growing American kinds, or, if desirable, of hybrids of the latter with indigenous varieties.

Soviet Union.—It is stated in *Russian Information and Review* (1924, 4, No. 21, 331) that cotton cultivation is being rapidly restored in most of the countries of the Soviet Union and especially in those in which co-operative cotton associations have been formed.

In Turkestan 658,000 acres have been planted this year, as compared with 433,000 acres in 1922–23. Progress is particularly marked in the Ferghana area, which, from being one of the most prosperous of the cotton-growing districts before the war, had become one of the poorest; the area planted this year is estimated at 278,000 acres, which, it is hoped, will yield 80,000 tons of raw cotton. The success achieved in this and other parts of Turkestan is due to the energetic measures adopted by the authorities in conjunction with the interest taken by the people in the resuscitation of the industry. The whole of the organisation of cotton-growing is now being conducted by local co-operative societies, the private middlemen being thus superseded.

In Bokhara not only has an increased area been planted but great success has attended the substitution of high-grade American seed for the inferior local variety previously sown. This development has been encouraged by the Bokhara Government who have exempted areas planted with the American seed from certain taxes, and also by the Russo-Bokhara Cotton Association who have made advances of seed and money to the growers. An area of 40,500 acres has been sown with the improved seed, and it is estimated that 1,000 tons of American cotton will be obtained this year, whereas last year there was no production of such cotton in this region. The area planted with the local variety of seed is estimated at 67,500 acres.

In Armenia arrangements were made for planting 37,000 acres, from which a crop of 7,000 tons of raw cotton is anticipated. The natives have shown a great desire to extend the area in order to restore their national prosperity. Considerable extension could be effected if irrigation schemes could be put into operation, but this unfortunately is not possible at present owing to lack of means.

Paper-making Materials

Triplochiton Johnsoni Wood.—In this BULLETIN (1920, **18**, 200) reference is made to the "Arere" timber of Nigeria derived from *Triplochiton Johnsoni*, C. H. Wright (= *T. scleroxylon*, K. Schum.). Examination of this timber at the Imperial Institute showed that it is a soft wood and would not be of value for building purposes in this country.

An account of an investigation of this wood (which is known in the Ivory Coast as "Samba" wood) as a possible paper-making material has been given by Prof. F. Heim (in collaboration with MM. J. Maheu, M. Cerclet, G. S. Dagand and R. Heim de Balsac) in the *Bulletin de l'Agence Générale des Colonies* (1923, **16**, 949). This work forms part of a general study of the value of the woods of the Ivory Coast for paper-making.

The wood contained 9·8 per cent. of moisture, and on chemical analysis yielded 1·77 per cent. of ash (composed of chlorine 46·5, soda 44·1, lime 1·0, and silica 8·4 per cent.), 0·56 per cent. of fats and waxes, 59 per cent. of cellulose and 39 per cent. of lignone. On digestion with solution of caustic soda under pressure, a reddish-brown pulp was obtained which was readily bleached, the yield of bleached pulp amounting to 33 per cent. (calculated for a moisture content of 5 per cent.). Paper made from this pulp was slightly rough to the touch, fairly supple, and of moderate strength but a little brittle.

On microscopical examination, the pulp was found to be composed of fibres with only a very small proportion of accessory elements (cells and vessels). The fibres have an average length of 1·4 mm., an average diameter of 20μ and a satisfactory felting power (*i.e.* ratio of diameter to length) of 0·015.

On the whole, the results of the investigation indicate that the wood can be readily converted into a paper of medium quality.

West African Corkwood.—In this BULLETIN (1921, **19**, 10) an account was given of an investigation at the Imperial Institute of the possibilities of the timber of the West African corkwood or umbrella tree (*Musanga Smithii*), and it was shown that this wood is a promising material for the manufacture of paper-pulp, yielding from 44 to 50 per cent. of dry pulp according to the severity of the treatment applied.

A report on trials carried out at the École Française de Papeterie by L. Vidal and M. Aribert has now been published in *L'Agronomie Coloniale* (December, 1923,

p. 159; and January, 1924, p. 13). The wood used in these experiments was derived from the Ivory Coast and was treated with solution of caustic soda under pressure. A yield of 48 per cent. of dry pulp was obtained, which, as found at the Imperial Institute, was somewhat difficult to bleach. The yield of the dry bleached pulp amounted to 43 per cent. Paper-making trials were carried out with this pulp and satisfactory papers were produced, specimens of which are included in the January, 1924, issue of *L'Agronomie Coloniale.* The papers were submitted to various tests and the results are recorded.

The authors conclude that the corkwood is capable of being converted into a useful pulp which can be manufactured into paper of good quality. It is considered that, under present conditions, it would not be feasible to manufacture paper in the Ivory Coast, but that it might be possible for unbleached pulp to be prepared there for export to Europe.

A further discussion of the possibility of manufacturing pulp locally from *Musanga Smithii* wood is given by P. Ammann in *L'Agronomie Coloniale* (February, 1924, p. 33).

MINERALS

Aluminium

United States.—The production of bauxite in the United States has, so far, been restricted to the States of Arkansas, Alabama, Georgia and Tennessee, the first-named being by far the chief contributor. The present output of about half a million tons per annum is rapidly depleting the bauxite reserves of these States, and this has caused attention to be directed to other bauxite occurrences, of which those of Mississippi appear to be the most important. Detailed information regarding the latter is given in *Bulletin* No. 19, *Mississippi State Geol. Survey*, December 1923.

The bauxite deposits of Mississippi are in the north and north-east parts of the State, and occur in the Wilcox formation of Eocene age. While the deposits are numerous, they are generally small individually. In many cases they are of too low a grade for commercial use without concentration.

The bauxite reserves in the State are estimated at 145,000 tons, containing 50 to 60 per cent. of alumina, 403,000 tons with 40 to 50 per cent. of alumina, and also about 1,000,000 tons of low-grade material, which would require concentration.

Coal

Nigeria.—A memoir on the Emugu area of the Udi-Okwoga coalfield by A. D. N. Bain has appeared recently as *Bulletin* 6, *Geol. Survey, Nigeria*, 1924. This coalfield was, as is well known, discovered in 1909 by officers of the Mineral Survey of Southern Nigeria, which was conducted in association with the Imperial Institute (see this BULLETIN, 1916, **14**, 369).

The age of the rocks is still a matter of uncertainty on account of the scarcity of good fossils. The Lower Shales (marine) are undoubtedly Cretaceous, but the Upper Shales (estuarine), the Coal Measures and the Sandstone Series may be passage beds from the Upper Cretaceous to the Lower Eocene. There has been no folding of the strata, but there are a few small faults in the area, the principal of which are shown in Plate X of the memoir. The coal is made up of alternate dull and bright layers; it has a well-developed cleat and is non-caking. According to Bain the earlier analyses (*op.cit.*, pp. 371 *et seq.*) underestimated the quality of the coal, and there is little doubt that as regards its class the coal can be placed between the low-carbon bituminous and the sub-bituminous divisions. There are five persistent coal-seams, the thickness of which varies from 4 to 64 in. Recent experiments carried out in England indicate that it is not impossible to make a coke of metallurgical value from Nigerian coal.

The mines are worked by adit. There is endless rope haulage at the Udi colliery. The coal is mined by the bord and pillar method. Naked lights are used throughout. Ventilation is effected by centrifugal fans placed at special adits.

The maximum output from the three mines, Udi, Iva and Obweti, was reached in 1920, with 2,016, 2,128, and 1,150 tons per week, respectively. The total output in 1922 was 110,785 tons. The cost of the actual coal-getting is about 2*s*. per ton, and the selling price at the mine in 1923 was about 10*s*. per ton.

The memoir is well illustrated with a geological map, mine sections and plates of views.

Cobalt

Belgian Congo.—The occurrence of cobalt in the Katanga copper-belt, Belgian Congo, is briefly described in the Imperial Institute Monograph, *Cobalt Ores* (p. 43). According to C. H. Luja (*Journ. Chem. Met. and Min. Soc., South Africa*, 1924, **24**, 249), cobalt ore is found in several places near the soft, so-called sandy copper

ores, in one of the copper mines, and near the radio-active ore mine. In all cases it is found in conjunction with manganese and in the form of a soft black mass (no doubt as asbolite), filling irregular spaces between dolomitic schists and dolomite, or in decomposition areas of the dolomite itself. Occasionally linnæite has been found in the solid dolomite, with beautiful erythrite in the fractures of the dolomite. The manganese-cobalt ore also contains some nickel and copper. A characteristic combination from ore near the radio-active ore mine is cobalt, 6 per cent.; nickel, 1·40 per cent.; and copper, 1 per cent.; but at the copper mine, where it is mined, the cobalt content in this soft ore ranges up to 14 per cent. with a little nickel and copper; part of the ore-body is so low in cobalt and high in copper that it is treated as a copper ore. Blocks of this black ore occur in a hard form, containing up to 40 per cent. of cobalt, with only traces of nickel and copper. A slight nickel-green coloration serves as an indicator.

The soft cobalt ore is made into bricks, which are burnt and stored during the progress of experiments to determine the most suitable method of extraction.

Copper

United States.—The copper deposits of the Kotsina-Kuskulana district of Alaska are described by F. H. Moffit and J. B. Mertie, Jr. (*Bulletin* 745, 1923, *U.S. Geol. Survey*). Copper prospects have so far been found in the upper part of the Strelna formation (Carboniferous,) in the Nikolai greenstone, and in the lower part of the Chitistone limestone (Upper Triassic). The deposits are classified as stringer lodes and contact deposits. The former lie in shear zones, in large measure along fault-planes and irregular fractures, and in places extend into the country rock. Most of them have been developed in the Nikolai greenstone. The ore-bearing bodies in the stringer lodes range from tiny veinlets of copper minerals up to large irregular bodies of ore in limestone, as at the Bonanza mine, in the Nizina district (see Imperial Institute Monograph, *Copper Ores*, 1923, p. 165). The contact deposits consist of disseminated copper minerals, and some bodies of ore which lie at or near the contact with intrusive granodiorite. The copper minerals include bornite, chalcopyrite, chalcocite, malachite, azurite, native copper, silver-bearing tetrahedrite, cuprite, covellite, and chalcanthite, named roughly in their relative order of abundance. The first two minerals and tetrahedrite are primary; chalcocite is sometimes primary and sometimes secondary; the re-

maining copper minerals are secondary. The following types of stringer lodes occur: (1) argentiferous tetrahedrite ores; (2) chalcocite ores; (3) bornite and bornite-chalcocite ores; (4) bornite-chalcopyrite ores; (5) pyrite-chalcopyrite ores.

A considerable amount of development has been accomplished at Clear Creek mines. The country rock is greenstone (Nikolai) near an intrusion of coarse-grained granodiorite. Both rocks are faulted and sheared. Along the borders of the granodiorite, the greenstone is mineralised with pyrite and chalcopyrite, which occur in veins along fault- and fracture-planes, stretching from N. 30° E. to N. 60° E., and as grains, leaves and small irregular-shaped bits of mineral replacing the greenstone or filling tiny openings along zones of fracture. There are four tunnels (adits) having a total length of 5,836 ft.

Gold

Southern Rhodesia.—The Shamva mines, Southern Rhodesia, are described by Cyril E. Parsons (*Bull. Inst. Min. and Met.*, March, 1924).

The country rock is described as being fine-grained and highly siliceous, with coarse grains of quartz and crystal of several varieties of felspars, one being microcline; dark mica is also present. The deposit is considered to be of sedimentary origin. The richest areas often occur where the ground is disturbed. The deposit has a N.E.–S.W. direction, with a slight dip north, without definite walls. The deposition of the gold appears to be dependent upon innumerable and almost imperceptible fissures, often associated with calcite. Ore occurs in lenticular masses along a line nearly 5,000 ft. in length. So far three dolerite ("diabase") dykes occur, which may cause enrichments below. A well-defined fault-plane passes through the mine at the fourth level, striking with the deposit and dipping at a flat angle north; this plane has cut off the ore bodies to a certain extent, but good ore has recently been discovered under the plane to the north.

Practically all the ore is obtained by underhand stoping from open-cast workings in daylight. In 1922 the value of the ore treated was 3·346 dwts. per ton. The extraction by amalgamation and cyaniding was 87·3 per cent. The working expenses (including all charges in Africa) were just under 9s. per ton.

Canada.—A reconnaissance of the little-known Whitewater district, 125 miles north of the city of Vancouver,

British Columbia, is described by George H. Shepherd (*Eng. and Min. Journ.-Press*, June 7, 1924, p. 930).

The north side of the Whitewater Valley consists of basaltic flows, tuffs, and igneous sills of porphyry (Taseko formation) of Tertiary age; the south side consists of massive quartz-diorites (Bendor batholith) of late Jurassic age; between the two is a much altered mass of older basaltic tuffs and lava flows and agglomerates (Denain formation).

The most interesting mineral occurrence in the district is that of the Mother Lode, which, striking E.–W., bisects the quartz-diorite batholith, near its contact with the Denain formation, for a length of 6,000 ft. The dip of the lode is southerly, and the elevation is about 8,000 ft. The deposit is 60 to 300 ft. in width, and consists of a true quartz-conglomerate, in which translucent crystals of quartz occur up to 1 in. or more in length, the cementing matrix being largely kaolin, calcite, limonite and felspar. In the deposit, gold, frequently coarse, occurs with azurite and malachite, galena and cerussite. The deposit has been trenched at surface, and samples have yielded from a trace to 15 oz. of gold per ton and from a trace to 17 oz. of silver per ton.

The geology of the Watabeag area, Ontario, is described by G. H. Wright in *Thirty-first Ann. Rept., Ontario Bur. Mines*, 1922, Pt. 7, (p. 1). It was in this area, which is situated about forty miles north of Gowganda and lies S.E. of Porcupine and N.W. of Kirkland Lake, that the earliest discoveries of gold were made in N.E. Ontario, in Playfair township in 1905, and in Terry township in 1908.

On the Mobb claim, Playfair township, two nearly vertical veins, striking E.–W., contain pyrite, chalcopyrite and minor amounts of molybdenite in a gangue of quartz and calcite. One sample taken across 4 ft. in a test-pit gave 3 oz. of gold and 9 oz. of silver per ton; but the contents were variable, for a second sample did not give such good results.

On the Biederman claims, Terry township, there is a shaft 20 ft. deep on a quartz-pegmatite vein, about 25 ft. wide, which cuts a pink granite. It has been explored to a depth of about 300 ft. by diamond-drill, and gold contents varying in value from 90 cents to $14 per ton were obtained from the core of one hole put down to a depth of 269 ft. in quartz, at an angle of 60° from the foot-wall side of the vein; the silver contents varied from 2 to 3 oz. per ton.

A shaft has been sunk to a depth of 25 to 30 ft. on two claims in Timmins township. Quartz veins here cut both the Keewatin schists and syenite-porphyry. A grab sample from these gave a gold assay value of $10·40 per ton.

Australia.—The Ortona gold-mines at Mount Moran, about three miles north of Ortona, and sixty miles from Forsyth, the terminus of the Etheridge Railway, in Queensland, are reported on by O. M. Williams (*Queensland Govt. Min. Journ.*, March, 1924, p. 87).

A chloritic bar, several hundred feet in thickness, and striking E.–W., intrudes the steeply inclined slate series to the north of Ortona. The rocks for some distance north and south of this bar are intensely metamorphosed. On the north side are three parallel lodes, approximately 100 ft. apart, striking N.N.E.–S.S.W. and nearly vertical. The lodes are fissure veins, the gangue being quartz, gossan and diorite, the ore itself forming a series of lenses of varying length and with a maximum thickness of about 6 ft. Good gold has been obtained along the main line of lode for a distance of over 600 ft. Very little exploratory work has been undertaken except along the Finger Print main line of lode, which is closest to the intrusive bar or dyke. The Finger Print claim itself has been opened up to a depth of 33 ft., the vein in the face being 3 ft. in thickness; about 12 tons of ore taken from the surface had an average gold content of about 2 oz. per ton. The Blue Spec is 30 ft. deep with 4 ft. of 2 oz. ore showing in the face; 30 tons taken from the surface averaged about 3 oz. of gold per ton. On the Mona, at a depth of 40 ft., the vein is 6 in. to 4 ft. in thickness, and contains about 1½ oz. of gold per ton; 300 tons at the surface averaged about 25 dwts. of gold per ton. The Dinkum is down 30 ft. and 30 tons at the surface averaged 1½ oz. of gold per ton.

Some small parcels of stone raised from the parallel lodes averaged about 1 oz. of gold per ton.

According to Williams, the lodes appear to be permanent, and present developments fully justify the erection of a battery.

Dutch Guiana.—The alluvial goldfields of Dutch Guiana are described by Bernard W. Holman (*Mining Magazine*, February, 1924, p. 85). From 1903 to 1912 the production of placer gold from native workings amounted to 319,052 oz. The deposits are largely covered by an overburden of 6 to 10 ft. of soft conglomerate. Samples of some of the

deposits taken in 1912 and 1913 varied in value from 2s. to 20s. per cubic yard. The Dieu Merci placer on the Sara Creek of the Surinam River has been estimated by the owner to contain a large tonnage averaging in value well over *7s. 6d.* per cubic yard. The Dutch Government records show that about £350,000 worth of gold has already been produced from Sara Creek by hand-washing. The Grand Creek and Cedar Creek, tributaries of the Murowyne River, have been favourably reported on. The Montana, near the left bank of the Surinam River, seventy-two miles south of Paramaribo, has been considerably worked by native labour.

The bedrock of the country is stated to be granite and gneiss. A metamorphic belt, some thirty miles wide, courses E. and W. through these rocks, and is intruded by quartz-porphyry and diorite.

Iron

Canada.—Iron-bearing rocks which are of some economic interest occur on islands in Lake St. Joseph, Ontario, and below some parts of the lake itself. These have been examined recently by E. L. Bruce (*Thirty-first Ann. Rept., Ontario Bur. Mines*, 1922, Pt. 8).

Lake St. Joseph lies in an area which is in part of the pre-Cambrian shield. The formation in which the iron-bearing rocks occur is of sedimentary origin overlaid with quartz-porphyry and andesite flows, and cut by lamprophyric and pegmatite dykes and granite batholiths, all of pre-Cambrian age.

These iron-bearing beds are not confined to any one horizon of the sedimentary series, but are thickest and most continuous in what is considered to be the upper part of the series. The ore-bodies are lenticular, the largest observed appearing to be continuous for about five miles.

The iron minerals are magnetite and specular hæmatite, which occur in fine grains intimately mixed with silica. Analyses of 7 samples showed an iron content ranging from 32·60 to 37·92 per cent., no sulphur, and only a trace of titanium. Determinations of phosphorus in three samples gave 0·1209, 0·1564, and 0·2305 per cent. respectively.

Magnetic concentration tests showed that by crushing the ore to pass a screen of about 200 meshes per sq. in. a concentrate containing nearly 60 per cent. of iron could be obtained, but that more than 30 per cent. of the total iron was not recovered.

These results indicate that the ore is of low grade. The cost of finely crushing the ore in order to make

magnetic concentration effective would be a serious item in the expense of producing a marketable or smelting product.

Manganese

Georgia.—The Dutch Consul at Constantinople has lately issued a report on the manganese situation in the Georgian Republic, a summary of which is given in *L'Echo des Mines et de la Métallurgie*, May 1, 1924, p. 196.

The manganese deposits in Georgia, in respect of the extent and quality of the contained ore, are perhaps the most important in the world, and in 1913 yielded an output of 1,289,370 metric tons. They have been described in detail in the Imperial Institute Monograph, *Manganese Ores* (p. 74).

According to the above-mentioned consular report the exports of manganese ore from Georgia, *via* the Black Sea, in the four years 1919 to 1922, amounted in the aggregate to 362,961 metric tons, whilst, for the first eight months of 1923, 261,872 tons were exported. Of the latter figure, 68,527 tons were consigned to England, a little over 55,000 tons to France, and 73,000 tons to Germany and Holland.

The dispute between the Russian and Georgian Governments on the subject of the exportations has been settled by the Georgian Government forming a new organisation known as "L'Administration autonome de l'Industrie du Manganèse," concerned solely with the mining and administration of the manganese deposits. This organisation has renewed the leases with the various established companies, but the concessions not previously leased are reserved to the State, and will be worked by the Administration.

There are in all 20 concessionaires of the following nationalities: 5 Georgian, 3 Armenian, 1 Russian, 2 Belgian, 2 British, 1 French, 2 German, and 4 Greek.

Mercury

Russia.—The discovery of native mercury and cinnabar in the Province of Ferghana, Russian Turkestan, is mentioned in the Imperial Institute Monograph, *Mercury Ores* (p. 48). Further information is given by William Roberts in an account of a reconnaissance in Turkestan and South Siberia published in the *Mining Magazine* (1924, **30**, 329). Some ancient mercury mines were visited by him in the Achar Range of mountains, on the border of Bokhara. At one of the mines, situated at an altitude of about 10,000 ft., the formation is described

as being steatitic in character, with a network of very thin cinnabar veins. Accumulated globules of mercury were observable all along the floor of the galleries. Everything pointed to a very extensive mercury industry having been carried on here in the past. It is generally supposed that the workings date back to the former inhabitants, the Kalmucks, of Mongol extraction, who roamed over these parts as well as Mongolia. Two other mercury localities were visited at an altitude of about 14,000 ft. Thin veins of cinnabar and globules of mercury in a steatitic formation were observed in all the workings that could be examined. The whole of the sides and galleries of the workings were oval-shaped and smooth, without any sign that an iron or steel tool had been used in the process of excavation.

Oil Shales

Esthonia.—The Esthonian oil shales are described in the Imperial Institute Monograph, *Oil Shales* (p. 53), and later information about them has been given in this BULLETIN (1922, **20**, 252). According to an article which has recently appeared in the *Petroleum Times* (June 21, 1924, p. 883), the production of oil shale in Esthonia in 1921, 1922 and 1923 amounted to 94,048 tons, 139,032 tons and 184,131 tons respectively. About 75 per cent. of the shale is used as fuel, as Esthonia possesses no coal-fields, and wood costs more than the shale. The oil shales are also used as a raw material for gas production, and the spent shale is utilised in the cement industry. In 1920 the Esthonian Government introduced a small German-made plant at Kochtil for the production of crude oil from the shales. This plant was so successful that a unit for the daily treatment of 200 tons of shale, with an estimated production of 40 tons of crude oil, is being installed. It is estimated that one ton of Esthonian crude oil will yield the following refined products in gallons: motor spirit, 60; illuminating oil, 30; lubricating oil and fuel, 90. The residue from the distillation is a soft pitch, which could be profitably disposed of, while other valuable by-products could also be recovered.

Petroleum

North Borneo.—The crude oil of Sarawak is described by James Kewley (*Journ. Inst. Petrol. Technol.*, 1924, **10**, 42). The production of petroleum in Sarawak has steady increased in recent years, amounting to 199,856 tons in 1921, and to 403,394 tons in 1922. The present weekly

production of the fields amounts to about 11,000 tons, which places Sarawak second to India in the list of oil-producing countries in the British Empire.

The crude oil occurs in sands of Miocene age, which are folded into a well-marked anticline, which is characterised by a series of minor faults and small overfolds. Oil has been found at all depths, down to about 2,000 ft., the deepest level so far worked. The character of the oil is generally uniform, but there is a distinct change in specific gravity with increase of depth, the lighter oil being found at greater depth, as is also the case in the Koetei fields of East Borneo (see this BULLETIN, 1921, **19**, 103). The oil is of the naphthenic type, but the recent appearance of a paraffin base oil at about 1,950 ft. leads one to suspect that, as is the case in East Borneo, wax-bearing oils may be characteristic of the lower levels. The crude oil is a mobile liquid, reddish-brown in colour and of agreeable odour. An analysis of an average mixture of the crude oils as produced, which had a specific gravity of 0·902, at 15° C., shows it to be deficient in fractions of low boiling point. It is free from paraffin wax, naphthenic in character and remarkably free from asphaltene. It has very low viscosity, low sulphur content and yields products which are easily refined.

Canada.—The "Preliminary Report on the Bituminous Sands of Northern Alberta," No. 281, by S. C. Ells, was issued by the Dominion Department of Mines in 1914. Subsequent and more detailed field work has adduced much additional information regarding the Alberta deposits, some of which is embodied in an article by Ells, which appears in recent numbers of the *Canadian Mining Journal* (March 28, 1924, p. 298, and April 25, 1924, p. 400). An official report will be issued later.

An accurate estimate of the area underlain by bituminous sand is not possible at present. The outcrops extend along the Athabaska River and its principal tributaries, through a total distance of more than 220 miles. The direct distance in a north and south direction through which outcrops have been noted is approximately 100 miles, and that from east to west about 35 miles, but the area actually available for commercial development at present probably does not exceed 1 per cent. of the above estimate. There is, of course, considerable variation in the thickness of overburden, character of material, grade of mineral aggregate and bituminous content.' Analyses of 37 samples, taken from various localities, range from 8 to 20 per cent. of bitumen, the

average being about 11½ per cent. A representative sample gave: specific gravity, 1·75; moisture, 1·3 per cent.; bitumen soluble in carbon disulphide, 18·5 per cent.; sand, 80·2 per cent. The sand consists for the most part of clear quartz grains. The greater part may be considered as having originated as shore deposits.

In order to determine the value of the bituminous sands for use as paving material, an experimental pavement was put down at Edmonton in 1915, which was still in first-class condition in 1923. In the United States bituminous sands and sandstones and bituminous limestones have been used to some extent as a surfacing material for city streets and country highways. Bituminous materials have also been used extensively in European cities for sidewalks for many years, and sidewalks made of bituminous sand with varying proportions of clean sand and crushed rock have been successfully used at Edmonton.

No successful commercial process for the recovery of hydrocarbon from Alberta bituminous sands has, so far, been demonstrated, but certain processes now being studied appear to possess merit.

Germany.—According to the *Petroleum Times* (May 10, 1924, p. 660), a well drilled at Dannhorst, near Celk, in the Province of Hanover, North Germany, encountered a violent eruption of oil and gas at a depth of about 2,000 ft. In the first three weeks the production of oil is estimated to have been 300 tons. The oil is similar to the so-called light oils of the Wietze region. The Hanover province has long been known as containing oil-bearing lands, but, so far, the production has been obtained from shallow depths. The oil occurs in salt domes analogous to the oil-yielding salt domes of Rumania, and of Texas and Louisiana in the United States. The oil appears to be confined to Trias beds, except that overlying beds of recent age have become impregnated with oil, which apparently has migrated into them. The Deutsch Erdöl A.-G. has recently commenced to exploit the previously drilled and exhausted oil sands by the shaft and tunnel method, which has proved so successful at Pechelbronn, in Alsace.

The Harburg district, at no great distance from the new find, is also a very promising one for oil. A well in this district, at a depth of 1,115 ft., entered a bed of sands saturated with a thick viscous oil, 65½ ft. thick. The well is now said to be about 1,900 ft. deep, and to have penetrated several other oil beds. These successive satu-

rated beds point to the presence of a productive stratum at greater depth.

Persia.—A paper by R. K. Richardson, of the Anglo-Persian Oil Company's geological staff, on the geology and oil measures of South-West Persia, was read at a meeting of the Institution of Petroleum Technologists on May 13, 1924 (*Journ. Inst. Petrol. Technol.*, 1924, **10**, 256).

Previously it was considered that the reservoir rock of the Maida-i-Naftun oil-field was detrital limestone of the Lower Fars gypseous group (see Imperial Institute Monograph, *Petroleum*, 1921, p. 59), but Richardson proves conclusively upon petrographical, palæontological and stratigraphical evidence that the oil-bearing limestone is identical with the limestone of the Asmari Mountain, which is probably of Oligocene-Lower Miocene age, the Lower Fars Series (Lower Miocene) forming the cap rock. Analyses of samples of the oil-bearing rock show it to be a highly dolomitic limestone. The rock is highly organic, being a richly foraminiferal limestone.

The crude oil of Maida-i-Naftun is described by A. E. Dunstan (*Journ. Inst. Petrol. Technol.*, 1924, **10**, 51). The output from this area in 1919, 1920, 1921, 1922 and 1923 amounted to 1,081,919, 1,354,631, 1,767,070, 2,310,098 and 2,913,908 tons respectively.

Persian crude oil is a brown mobile liquid, with a green fluorescence. Its mean specific gravity is 0·837. It is an oleosol in which small amounts of asphaltic compounds and amorphous waxes are dispersed in a hydrocarbon continuous phase. The oil is chemically a "mixed base," crude, predominantly paraffinoid. Like most oils of Asiatic origin, it contains a notable proportion of aromatic hydrocarbons. The benzene fraction, for example, contains 10 per cent. of benzene, toluene and xylene. The sulphur content of the crude kerosene averages 0·15 per cent. The most efficient means of reducing the sulphur content and removing the colouring matter in one operation consists in a simple filtration through bauxite. Usually 2 lb. of bauxite are used to the gallon of filtrate, whereby the sulphur content is reduced to rather less than 0·1 per cent., and a colour superior to "water white" is obtained.

Persian crude oil contains less than 0·01 per cent. of ash which has the following percentage composition: Fe_2O_3 and Al_2O_3, 26·96; CaO, 2·31; MgO, 1·18; V_2O_5, 5·03; NiO, 2·70; MnO, 4·39; SiO_2, 2·29; P_2O_5, 5·53; SO_3, 35·29. The most striking feature is the large percentage of vanadium and nickel present. The ash exhibits a small degree of radio-activity.

Silver

United States.—The Betty O'Neal mine, Nevada's newest silver producer, is described by Walter S. Palmer (*Eng. and Min. Journ.-Press*, March 15, 1924, p. 449). The mine, which was worked on a small scale from 1880 to 1882, was unwatered a few years ago, and in 1922, a Minerals Separation flotation mill of 150 tons daily capacity was erected, a second unit, of similar capacity, being added in 1923. The extraction at present is 95 per cent.

Two fairly well-defined veins are being worked, which strike N.–S. and dip W. 45°. The country rocks are limestone and slate cut by porphyry dykes. In places the limestone is highly silicified. The ore-bodies have been opened up to 1,600 ft. on the dip. On the No. 4 tunnel the vein has been drifted on for 1,200 ft., and is 12 to 55 ft. wide, the ore containing an average of 20 oz. of silver per ton. The ore is a mixture of silicified limestone and slate, which has been fractured and cemented by calcite and quartz. It contains much graphite and some barytes. The chief metal contents are silver, with some copper and lead and traces of gold. The chief silver mineral is freibergite (argentiferous tetrahedrite) with accessory stephanite, argentite and polybasite. The associated minerals are galena, tetrahedrite, pyrite and blende. In the oxidised zone cerargyrite is associated with azurite and malachite. The ore-bodies appear to be replacements in limestones with subsequent fracturing and filling of the fractures.

Tin

Australia.—The Blue Tier tinfield of N.E. Tasmania is described by James B. Lewis (*Chem. Eng. and Min. Rev.*, December 5, 1923, p. 91). The deposits consist of lode formations in granite, near which sedimentary rocks sometimes occur, and of alluvium. The lodes run N.–S. and are practically vertical. Some flat seams of pegmatite also occur, which are usually of low grade. In the larger formations the cassiterite is occasionally accompanied by small quantities of wolframite, molybdenite, and chalcopyrite, these minerals, together with cassiterite, being more common at the points where dolerite (" diabase ") dykes, running N.E.–S.W., cut through the lodes. The large tin-bearing bodies extend over considerable areas, though the tin does not usually last to any depth. Enrichments usually appear to run no deeper than 20 to 30 ft. from the surface of the formation. The ore is of low grade.

According to the records, 1,395,750 tons crushed at the Anchor mine referred, to in the Imperial Institute Monograph, *Tin Ores* (p. 7), yielded 2,723 tons of tin, or an average of 4·37 lb. per ton. Lewis, by systematic sampling, obtained 3·5 lb. per ton, or 0·20 per cent. of cassiterite. It is obvious from these figures that the properties must be worked on a large scale and at a low cost in order to yield a profit.

Some of the fissure lodes explored contain wolframite, fluorspar, calcite, molybdenite (plentiful), a little chalcopyrite and a few specks of bismuth. Felspar forms a considerable part of the veinstone; green talc and altered mica are common. There are vugs in the quartz, lined with crystals.

Bolivia.—The tin deposits of Chacaltaya, Bolivia, are described by Waldemar Lindgren (*Econ. Geol.*, 1924, **19**, 223). The Chacaltaya district lies on the slopes of the Cordillera Real at an elevation of about 15,000 ft. The country rock consists of black slates and quartzite (probably Devonian), near intrusive granite. There are numerous veins striking E.–W., and dipping steeply N. or S. The width ranges from a few inches up to 3½ ft. The ore appears to fill open fissures, and is in part massive and in part crystallised on quartz crystals, which form a comb-structure in the veins. One vein, called the fluorspar vein, carries massive, white or iron-stained ore, with occasional small drusy cavities in which quartz crystals project. Dark brown cassiterite in small crystals or crystalline masses is attached to a groundwork of milky quartz. White fluorspar fills in the interstices, and cements the earlier crystals into a massive ore. The succession is (1) quartz; (2) cassiterite; (3) fluorspar; (4) pyrite. Tourmaline in small quantities was deposited at least during the later and larger part of the mineralising period.

The Veta de Hierro is richer in cassiterite and contains more tourmaline and less fluorspar than the vein just described. The succession here is: quartz; tourmaline; cassiterite; lepidolite; stannite; fluorspar; pyrite. Both quartz and tourmaline have a longer range of formation than the remaining minerals.

NOTICES OF RECENT LITERATURE

GUIDE TO RHODESIA: FOR THE USE OF TOURISTS AND SETTLERS. With illustrations, maps, and plans. Second and Revised Edition. Pp. xvi + 432, $7\frac{1}{4} \times 4\frac{3}{4}$. (London: Beira and Mashonaland and Rhodesia Railways, 2, London Wall Buildings, E.C.2, 1924.) Price 2s. 6d.

It is not easy in a short notice to give an adequate idea of the mass of information contained in this well-printed and attractive volume, the preface to which describes its object as that of "providing a comprehensive yet concise survey of the Colony of Southern Rhodesia, its history, topography, climate, health conditions, and natural resources, with an outline of the possibilities for the investor, the farmer, and the tourist and sportsman." The work is embellished by a large number of photographs, illustrating the scenery, antiquities and industries of Rhodesia. Special mention may be made of the sections furnishing practical information for intending or newly-arrived settlers, and those of more general interest dealing with the famous antiquities of the country and with the Victoria Falls.

An excellent bibliography is provided for the benefit of readers inclined to study the country in greater detail. Many will be surprised to learn of the writings of Arabian, Persian and Portuguese travellers, describing parts of what is now Rhodesia in days long previous to the British occupation, and will note with interest the copious literature which has sprung up in recent years.

Northern Rhodesia (comprising the former divisions known as North-Eastern and North-Western Rhodesia) is dealt with in a special chapter, and incidentally in other parts of the volume. Every part of the Guide is replete with interest, and anyone concerned with Rhodesia, as colonist, traveller, trader, sportsman, or administrator, or as a general student of the life and history of the country, would be well advised to acquire the book and to read it from cover to cover.

CYPRUS: A BRIEF SURVEY OF ITS HISTORY AND DEVELOPMENT. By W. H. Flinn. Pp. 90, $8\frac{1}{2} \times 5\frac{1}{2}$. (Cyprus: The Government Printer, Nicosia; London: Crown Agents for the Colonies, 1924.) Price 2s. 6d.

This is a handy volume, printed in large, clear type, and containing a number of beautifully reproduced photographs illustrating the scenery, towns, and industries of the island. After an introductory chapter, the author,

whose style is concise and interesting, gives a summary of the chequered history of Cyprus, from the first establishment of Egyptian dominion (about 1450 B.C.) up to the annexation of the island by Britain during the late war; the antiquities are briefly dealt with, and chapters follow on the government, finance, shipping and communications, agriculture, forestry, industries and natural resources of the country. The interest of possible readers may be stimulated by quoting Mr. Flinn's concluding words: "Cyprus is a country full of anomalies and anachronisms; ethnologically European, it is geographically Asiatic; its contiguity to the Near East is reflected in its oriental atmosphere; it is one of the homes of the pan-Hellenistic idea. To the archæologist, to the historian or to the seeker after peace, it is one of the most enchanting spots in the world."

TANGANYIKA EXHIBITION HANDBOOK. Pp. iv + 215, $7\frac{1}{4} \times 4\frac{3}{4}$. (Issued by the British Empire Exhibition Central Committee of Tanganyika, 1924.) Price 1*s.*

This handbook has been published in connection with the British Empire Exhibition, but its utility and interest should secure for it many readers who do not actually visit Wembley. It follows the general lines of many of the other handbooks noticed from time to time in this BULLETIN; it gives a comprehensive account of the Territory, subdivided under suitable headings, and enables the reader to form a good idea of the conditions of the country in recent years under both German and British rule. Considerable space is rightly devoted to agriculture and to the prospects of its development by European planters, as well as natives, under the auspices of the new Department of Agriculture set up by the British Administration; whilst another instructive section deals with mining and minerals.

The book, which contains maps, illustrations and statistical tables, might usefully be reissued from time to time as a general handbook for the Territory.

BRITISH GUIANA. Pp. 100, $8\frac{1}{2} \times 5\frac{1}{2}$. (Published at the British Empire Exhibition, 1924.)

Like the volume on Tanganyika described above, this book, though primarily intended for visitors to the Exhibition, might well be reissued later as a regular official handbook. It is well written, produced in good style, and contains numerous excellent photographs, of which perhaps the most striking is the frontispiece, a view of the

great Kaieteur Falls on the Potaro River, which have a vertical drop of no less than 740 feet.

The handbook contains much information on the geography, inhabitants, climate, fauna and flora, agriculture and industries of the Colony, which is noteworthy for the large number of immigrants it has received from India. In the census of 1921, out of a total population of about 298,000, nearly 125,000 persons were returned as "East Indians," and over 117,000 as "Blacks and Africans"; "Portuguese" (largely the descendants of immigrants from Madeira) amounted to some 9,000, but persons of actual European origin to only 3,300. Chinese, "mixed races" and aborigines made up the balance; the last-named officially numbering only 9,150, though it it admitted that no exact figure can be given.

The Colony is thus inhabited, like the West Indies, mainly by coloured persons of exotic origin. For a great many years the immigrants have consisted almost entirely of "East Indians," and though in 1917 the influx ceased (at all events for the time being) this element in the population is of great importance from an economic point of view. The question of a possible resumption of immigration from India is discussed in the handbook.

Apart from cultivated commodities, particularly sugar (exported in 1923 to the value of over £2,130,000), the Colony has large natural resources, both vegetable and mineral. The present work gives a good account of these and the conditions under which they are being or might be exploited, and concludes with a chapter on "Opportunities for Capital," in which the opinion is expressed that the country has room for millions of inhabitants. However this may be, it is clearly shown in this handbook that the development of the Colony's resources is still in a preliminary stage and that in certain directions there is immense scope for commercial enterprise.

Economic Geography. By R. H. Whitbeck and V. C. Finch. Pp. x + 558, 9 × 6. (London and New York: McGraw-Hill Book Co., Inc., 1924.) Price 17*s*. 6*d*.

The authors of this volume are respectively Professor and Associate Professor of Geography at the University of Wisconsin, and this alone should indicate that their book is worthy of a place among the authoritative technical works issued by the McGraw-Hill Book Company. Nor will the reader who takes this view be disappointed. The following paragraphs from the Preface give the key to the entire volume and show the spirit in which the authors have performed their task:

"In writing the book the authors have tried to emphasise cause and effect relations and to show how peoples, in pursuing their economic activities, have adjusted themselves to their geographical environment; for example, to indicate *why* particular crops are raised in certain places and others in other places; and *why* one nation has directed its economic life along certain lines and another along other lines. The idea of human adjustment to geographic environment is the keynote of modern geography, especially when pursued by students of college age, for whom this book is designed. It is this study of human adjustments that lifts geography to the level of a science and gives it a considerable part of its educational value.

"But the body of knowledge included in Economic Geography has also a high utilitarian value. It has something to contribute to those citizens who would have a world outlook and an international point of view. A knowledge of the poverty or plenitude of the resources of the various countries, of their stage of industrial development, and of their elements of economic strength or weakness, is a kind of knowledge that educated people need and use."

Many passages in the volume similarly show the perspicacity and the broad outlook which the authors have brought to bear on their subject. The book is excellently printed, and is amply provided with maps, diagrams, tables, illustrations and references to other works. It is naturally written mainly for American students, and therefore from an American standpoint, but no student of political or economic geography will regret its perusal or withhold his appreciation of the illuminating manner in which the subject is dealt with.

A survey of the sections dealing with European countries will show how up-to-date and generally trustworthy is the information given. The European student, moreover, will find the American sections of special interest, and will be grateful to the authors for their clearness and precision. Relatively little is said regarding the less "advanced" regions of the globe, such as parts of Africa and Asia, but this is quite in keeping with the general plan of the work, and even in these cases the authors have endeavoured to indicate the directions in which development is trending, and the possible future importance of regions at present outside the main stream of civilised commerce or not greatly contributing to it.

If the book is periodically revised to keep pace with political and commercial changes it should long remain a standard textbook.

THE CONSTITUTION, ADMINISTRATION AND LAWS OF THE EMPIRE. By A. Berriedale Keith, D.C.L., D.Litt. Pp. xxii + 355, 8¾ × 6. (London: Glasgow, Melbourne, Auckland: W. Collins, Sons & Co., Ltd., 1924.) Price 16*s.*

This book is one of a series of twelve volumes, edited by Hugh Gunn, M.A., each self-contained, describing the growth, development, organisation, and resources of the British Empire. The subject matter is divided into two parts. In the first part the author deals with the Constitution. The nature and source of constitutional law is first described, after which the constitutional structure of the Empire is dealt with, including the relationship of the Crown to the Executive, the legislative powers of the Dominions and Colonies and their limitations, the judiciary, the prerogatives of mercy and of the conferring of honours, and the regulations affecting the use of national ensigns.

The foreign relations of the Empire are next discussed. The unity of the Empire in international law is affirmed, although under the League of Nations this unity is seen to be largely lost. Methods of international intercourse are described, and the conditions respecting acquisition or loss of British nationality stated.

Considerable space is then devoted to the matter of co-operation within the Empire, not only in foreign affairs and defence, but also in domestic affairs. The important question of Indian immigration within the Empire is included in the latter.

After an account of the mode of government of the native races, again involving the colour question, the first part of the book closes with statements relating to the rights of the subject, and to the relationship of Church and State.

The second part of the book is mainly devoted to the various systems of Government in force among the different members of the Empire, including the administration of the Mandated Territories. Powers of extra-territorial jurisdiction are also described.

There follows a brief discussion of problems of the future constitution of the Empire, with a scheme of its present political organisation.

The book closes with a copious bibliography and a comprehensive index.

Within the narrow limits at his disposal the author has succeeded in presenting a remarkably clear account of this particular aspect of the British Empire of to-day. The book is full of interest, and should be widely read.

COMMUNICATIONS. By W. Tetley Stephenson. Pp. xli + 180, 10 × 7½. (London: Ernest Benn, Ltd., 1924.) Price 21*s.*

This work forms the tenth of a series of twelve volumes dealing with the resources of the British Empire. It contains a full and comprehensive account of the transport conditions and facilities existing to-day throughout the Empire, whether by waterway, road, rail, or air. Communication systems by cable, wireless telegraphy and telephony are also described. The author is to be congratulated upon the success with which he has compressed so much essential information into so small a space while at the same time producing an interesting and readable book. Shipping is given the place of chief importance. After reviewing the present condition of British shipping, the book passes to the consideration of bills of lading under the Hague rules (1924), and shipping freightage. Sea routes, with their *raison d'être*, are next dealt with, and finally the ports and docking facilities of the Empire are considered.

Railway communications are described in five chapters, a separate chapter being devoted to each of the continents. The question of road maintenance and transport is then discussed, and, after a short account of the inland waterways, which the author considers of comparatively small value, there follows a chapter on transport by air by an anonymous contributor who states that the airship, "if it is given the public support it deserves, will revolutionise the commercial and political outlook of the whole Empire." A chapter by Sir Alan Anderson, K.B.E., on "Overseas Mail by Air and Ship," is also included. Finally, after two chapters on communications by cable and by wireless respectively, the book closes with a short discussion on Imperial policy in communications.

The volume is well furnished with maps illustrating shipping routes, railway, air and wireless services.

MANUAL OF CULTIVATED PLANTS. By L. H. Bailey. Pp. 851, 8¼ × 5¼. (New York: The Macmillan Company; London: Macmillan & Co., Ltd., 1924.) Price 31*s.* 6*d.*

This manual is intended to serve the purpose of a garden flora for the identification of plants in cultivation in the United States and Canada. The preparation of the manual was commenced some forty years ago and has involved the cultivation of a large number of plants and the assembling of considerable herbarium collections in order that the diagnoses might be drawn up or verified

from the specimens themselves. The work is therefore original and not merely a compilation. The arrangement of the work follows the lines of a flora of a country, and keys are provided to enable the user to "run down" a plant by first finding its family or natural order, next its genus, and finally the species and name. The natural orders or families run from Agaricaceæ to Compositæ, and the descriptive matter is in technical language involving a knowledge of botanical terms on the part of the user, although assistance in this respect is furnished in the very full glossary of terms and names, which is given in the first part of the book. The manual contains descriptions of 3,665 species belonging to 1,246 genera and 170 natural orders or families. Native species and garden varieties and forms are excluded, the former being already dealt with in the floras of the countries concerned, whilst the inclusion of varieties would have greatly increased the size of the work and would have involved the preparation of large reference collections as well as a special application of nomenclature. Descriptions of garden varieties and forms must therefore be sought for in dictionaries and cyclopædias of horticulture. To those who have sufficient botanical knowledge to enable them to use it, the manual should provide a very useful addition to horticultural works of reference and it should find a place with dictionaries and cyclopædias in all garden libraries.

As most of the species in cultivation in the United States and Canada are also found in European gardens, the manual should prove of service in countries other than those for which it has been specially prepared.

COTTON IN AUSTRALIA: THE POSSIBILITIES AND THE LIMITATIONS OF AUSTRALIA AS A COTTON-GROWING COUNTRY. By Richard Harding, Secretary to the British Cotton Delegation, 1922. Pp. xviii + 270, 8½ × 5½. (London: Longmans, Green & Co., 1924.) Price 12*s.* 6*d.*

The author of this work has spent eighteen months in Australia, studying the local conditions in various parts of the Commonwealth in their relation to cotton-growing. The conclusions at which he has arrived are concisely summarised as follows in the last paragraph of the preface: "A comparison of climates shows that many parts of the States of Queensland and New South Wales are more suited to cotton than either the Nile Delta of Egypt or the United States of America. Cotton has given such great promise in these localities of Australia as fully to convince the writer that not only can that country, with her white labour, successfully compete in open markets, but that

she is eventually destined to become one of the great cotton-producing countries of the world."

After an introduction dealing with the uses and different varieties of cotton and the present shortage of the fibre in the world's markets, the history of cotton-growing in Australia is reviewed and the past and present conditions of the industry are discussed. The main causes of failure in the past are enumerated, as (1) the difficulty experienced by growers in disposing of the crop; (2) the slowness and uncertainty of transport; (3) the lack of business organisations for marketing; (4) the scarcity of population; (5) the careless methods of cultivation practised; (6) the fluctuations in market prices, and (7) the difficulty of obtaining labour. It is shown that all these obstacles can be surmounted and the greatest of them have already been overcome; and special emphasis is laid on the important action of the Queensland and New South Wales Governments in prohibiting the practice of ratooning cotton and in making it compulsory that all the plants should be uprooted at the end of each season.

The suitability, in respect of climate and rainfall, of various areas in New South Wales, Queensland, the Northern Territory and Western Australia is discussed, and a description is given of the conditions existing in the Irrigation Areas, consisting of the lands adjacent to the River Murray and its tributaries, the Darling, the Lachlan, and the lower reaches of the Murrumbidgee River. Later chapters deal with soils and soil analyses, the control of the seed supply, and the methods of cultivating the crop in Australia.

In the concluding chapter, after insisting on the urgent need for scientific research, the author refers to the fact that cotton-growing in Australia will most probably be restricted to small individual areas, averaging about 10 acres per grower, which can be worked by the cultivator and his family, without employing labour from outside. The size of the crop must be limited to the amount which can be picked, for whereas one grower could easily cultivate 30 acres, he could only pick 10 acres unaided. It is therefore necessary that types of cotton should be grown which can be easily and rapidly picked, such as big-bolled American Upland varieties. Other questions considered are the periods of planting, and the cotton lands available; advice is given to immigrants who intend to take up cotton growing and the future of the industry is discussed.

In appendixes to the work are given certain particulars of Egyptian temperatures and soil analyses, data of the average monthly rainfall of New South Wales and

Queensland, and an account of the diseases to which the cotton plant is liable in Australia. A short list of important books of reference is also provided.

The book contains a number of excellent photographs and diagrams, and will be of great service to the development of the Australian cotton-growing industry.

RICE. By E. B. Copeland, Professor of Plant Physiology and Dean of the College of Agriculture, retired, University of the Philippines. Pp. xiv + 352, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Macmillan & Co., Ltd., 1924.) Price 20s.

Professor Copeland is to be congratulated on utilising his retirement to such good effect in producing this excellent treatise on what he rightly calls "the world's greatest crop." In view of its importance as a foodstuff —it is probably the staple food of the greatest number of people, and men live on it more exclusively than on any other food—rice has naturally been the subject of extensive study from every possible point of view in countries where it is grown and in those otherwise interested in its production. The results of this work have been made available to the public in scattered journals and in miscellaneous publications dealing with special aspects of the subject, but never before has this mass of information been collected together for the use of English-speaking races.

The author has had first-hand experience in rice-growing in California and the Philippines, and a large proportion of the book is devoted to the methods and conditions obtaining in those regions. Although these areas are of relatively minor importance in the world's production of rice, the methods followed there represent respectively the best Western and Oriental practice and the detailed particulars given will be of considerable value to rice-growers in other countries.

The first chapter, on "The Botany of Rice," deals especially with the physiology of the plant, the information on the water requirements and nutrition of the growing crop being particularly valuable. Then follows an account of the climate and soil conditions most favourable to the plant, full particulars of the diseases and pests which attack it (illustrated by two excellent coloured plates of insect pests) and a detailed discussion of the seed and varieties of rice, including seed selection and hybridisation.

These matters occupy roughly half the book, the remainder being devoted chiefly to rice in the United States, Philippines, and other lands, including Indo-China, Siam, India, Ceylon, Malaya, Java, China, Japan, Spain and

Italy. The accounts relating to the first two countries mentioned are well illustrated by reproductions of photographs showing methods of cultivation, machinery employed, etc. There is a brief chapter on the uses of rice, and the book concludes with general discussions on the commerce of rice, and on economics and social considerations.

THE COCONUT PALM: The Science and Practice of Coconut Cultivation. By H. C. Sampson, C.I.E., B.Sc. Pp. xiv + 262, 8vo, 10 × 6½. (London: John Bale, Sons & Danielsson, Ltd., 1923.) Price 31*s*. 6*d*.

This beautifully produced volume is not to be regarded as a complete treatise on coconut cultivation, but rather as supplementary to the several excellent textbooks on the subject already published. It deals more with "Science" than "Practice," viz. that science on which the best practice should be based. In the first chapter, on the root system, for example, the relation between the extent of that system and the rate of growth of the palm and its bearing qualities is discussed in great detail, and illustrated by long tables of figures resulting from observations made in Southern India. The morphology of the stem and leaf, pollination, the development of the fruit and germination of the seed, are all similarly dealt with. The chapter on manuring, too, is full of most valuable original data, the composition of the various parts of the plant being nowhere given in more detail.

The practical side of the subject and the utilisation of the products of the coconut palm are discussed almost entirely from the point of view of the conditions obtaining on the Malabar Coast, where Mr. Sampson has gained first-hand experience as Director of Agriculture in the Madras Presidency. Insect pests and fungoid diseases are only mentioned incidentally, which is rather a pity in view of the large amount of work done in India on this side of the subject.

The large number of coloured plates are a special feature of the book, although the production of these has made it rather expensive. One expects in a book of this kind references to literature, and their complete absence in the present case somewhat detracts from its value.

LUCERNE CULTURE IN SOUTH AFRICA. By H. D. Lappan, B.Sc.A. Professor of Agronomy, Transvaal University College, University of South Africa, Pretoria. Pp. 68, 8½ × 5½. (South Africa: Central News Agency, Ltd.; London: Gordon and Gotch, Ltd., 1924.) Price 6*s*.

This small book is one of the South African Agricul-

tural Series which is being specially prepared to meet the needs of the farmer and student in the Union. The lucerne crop, or alfalfa as it is called in the United States, is one of the most important fodder crops in South Africa where irrigation water is available. Introduced into South Africa about the middle of the last century, its cultivation owes its chief impetus to the domestication of the ostrich, lucerne being the most valued food for this bird. In 1921 the area under lucerne in the Union was 141,750 acres and the production 83,253 tons, and this is likely to be largely increased during the next decade as the completion of irrigation schemes renders further suitable land available. In the author's opinion there is grave danger of an over-production of lucerne unless the dairy and kindred industries are more fully exploited and organised so as to absorb increased quantities.

The eight chapters into which this treatise is divided deal respectively with the history, description, classification and varieties of the lucerne plant; the production, climatic and soil requirements of the crop; seed and seed control; cultural considerations, including the preparation of the seed-bed, irrigation, harvesting and seed-production; the composition and feeding value of lucerne, with a reference to the bloating caused by feeding it to ruminants, a subject which is much in need of further investigation; the uses of lucerne, with suggested rations for cows, horses, pigs, and poultry; the improvement of the lucerne crop by means of selection and cross-pollination; and finally the diseases and pests to which the crop is liable. It will be seen, therefore, that the scope of the book meets the needs of those for whom it was prepared, and, in view of the special conditions that obtain in South Africa, it should prove helpful to all who cultivate or use lucerne in that country.

THE COCOA AND CHOCOLATE INDUSTRY: THE TREE, THE BEAN, THE BEVERAGE. By Arthur W. Knapp, B.Sc., F.I.C. Pp. 147, 7 × 5. (London: Sir Isaac Pitman & Sons, Ltd., 1923.) Price 3s.

This concise little volume is one of Messrs. Pitman's series of handbooks on Common Commodities and Industries, and is distinct from Mr. Knapp's previous work on the subject which was reviewed a few years ago in this BULLETIN (1920, **18**, 570). It can be strongly recommended as a popular treatise, and also as a brief technical handbook for those concerned with the production, sale, or manufacture of cocoa and its products, since it is not only written by an acknowledged expert, but furnishes a

very instructive description of the cocoa and chocolate industry, from the growth and cultivation of the trees to the final stages of manufacture. The subject is clearly and attractively dealt with, and the book contains numerous illustrations, diagrams and tables, which add considerably to its interest and utility. References are given to a number of standard works and other publications for the benefit of those wishing to study the industry in greater detail.

THE DISEASES OF THE TEA BUSH. By T. Petch, B.A., B.Sc., Botanist and Mycologist to the Government of Ceylon. Pp. xii + 220, 8vo, 9 × 6. (London: Macmillan & Co., Ltd., 1923.) Price 20s.

The tea-bush is on the whole a very hardy plant and has not hitherto suffered exceptionally from any disease, differing markedly in this respect from the coffee plant, which was practically eliminated from Ceylon in the seventies by the well-known leaf-disease. Only a dozen diseases were described by Watt and Mann in their account of the diseases of the tea bush published in 1903, but in the present excellent work some sixty diseases are enumerated. As the author states in his preface, this large increase is not an alarming one when it is remembered that the investigation of the diseases of tea on the spot has been almost entirely subsequent to the publication of Watt and Mann's book, and that part of the apparent increase is due to the closer investigation of the old diseases and the consequent recognition of different diseases which were formerly grouped together under one name.

The comparative immunity of the tea-bush from disease is largely due to the conditions under which it is grown. The periodic pruning tends to keep down the humidity of the air round the shoots and at the same time affords an opportunity of getting rid of various diseases. The systematic manuring which is now generally practised also assists in keeping disease in check. Mr. Petch points out, however, that there are signs that diseases are becoming more prevalent and he has been induced to write the present work in order that the planter may recognise the diseases which have been recorded, and may take steps to control them when they appear or to lessen the probability of their occurrence.

An introductory chapter deals with the various groups of fungi, and is intended rather as a running glossary than as a complete account of the classification of fungi. The diseases themselves are dealt with according to the part of the plant affected, information of special interest

to the planter, such as the effect of the disease on the bush, its symptoms and means of combating it, being given special prominence. Matters of more particular interest to the mycologist, such as notes on nomenclature and related matters, and diagnoses of the fungi causing disease are given in separate chapters. There is a brief account of wound covers, sprays and spraying machines, and a useful bibliography. In addition to about 70 reproductions of line drawings and photographs in the text, there are three excellently produced coloured plates depicting leaf, stem and root diseases.

Mr. Petch is to be congratulated on having produced what will for long remain the standard work on tea diseases, a book that should be in the hands of all interested in the production of one of the most important products of the Empire.

OUTLINES OF FUNGI AND PLANT DISEASES FOR STUDENTS AND PRACTITIONERS OF AGRICULTURE AND HORTICULTURE. By F. T. Bennett, B.Sc. (Lond.). Pp. xi + 254, $7\frac{1}{4} \times 4\frac{3}{4}$. (London: Macmillan & Co., Ltd., 1924.) Price 7*s*. 6*d*.

This little book is intended more particularly for the use of students of agriculture and horticulture to whom a knowledge of the life-history of the fungi causing the diseases of crops is essential for the successful combating of such diseases. The subject is dealt with in two parts. Part I is a brief general introduction to the study of fungi, illustrated by reference to a number of commonly occurring forms. Although these are not in all cases the cause of plant disease, they satisfactorily serve the objects in view, one of the chief of which is to train the student in following for himself the life-history of the fungus. For this purpose practical exercises are given in connection with each fungus described, and general instructions regarding the microscopic examination of fungi and their culture in artificial media are dealt with in an appendix.

Part II is concerned solely with plant diseases and the fungi which cause them, the causal organisms of the most common diseases of field and garden crops being considered in their proper systematic classes. The life-histories of the organisms are outlined and the general features by which the diseases may, as a rule, be recognised without the aid of a microscope are described in simple language. Preventive and remedial measures are given in each case, a general account of sprays and spraying being included in an appendix.

The illustrations of the microscopic structure of the

fungi, although somewhat crude, are adequate, but those showing the external appearance of the diseases will in many cases be of little value in assisting the student in their identification. On the whole, however, the book may be recommended to those requiring a simple introduction to the diseases of plants.

PLANTS POISONOUS TO LIVE STOCK. By Harold C. Long, B.Sc. (Edin.), of the Ministry of Agriculture and Fisheries. Second Edition. Pp. vii + 120, $9\frac{1}{4} \times 6\frac{1}{4}$. (Cambridge: At the University Press, 1924.) Price 8*s*. 6*d*.

This work, the first edition of which was published in 1916, gives a systematic account of the plants occurring in the United Kingdom which are poisonous to stock. The subject is of much importance to farmers and veterinary surgeons, as considerable losses are incurred every year owing to the ingestion of such plants by animals. By the collection of the available information from a great number of widely scattered technical reports and journals and its incorporation in one small handbook, the author has performed a useful service.

In an introductory chapter brief reference is made to the harm caused by poisonous plants, the circumstances in which the poisoning occurs, the effect of soil, climate and cultivation on the toxic properties, the relative toxicity of the different parts of plants, the methods of eradicating poisonous plants, the treatment of poisoned animals, the testing of poisonous plants, the legal aspect of such poisoning and the nature of the toxic principles.

In following chapters the various plants, arranged in their respective natural orders, are dealt with in turn, information being given in each case regarding the symptoms they produce and the toxic principles they contain, together with references (indicated by numbers) to the bibliography provided at the end of the book. Mention is made of a number of plants suspected of being poisonous but of which many are probably quite harmless in practice whilst others may possibly be deleterious in certain circumstances. Information is also supplied on the effects of certain plants on the milk and butter of animals which eat them, and on plants causing mechanical injury. The final chapter gives a list of British poisonous plants classified according to the symptoms they produce.

THE FARMER'S RAW MATERIALS. Air, Water, Soil, and Manure. By James Hendrick, B.Sc., F.I.C., Strathcona-Fordyce Professor of Agriculture, Aberdeen Uni-

versity; Director of Studies and Research, North of Scotland College of Agriculture. Pp. xv + 211, 7 × 5. (Edinburgh: W. Green & Son, Ltd., 1923.) Price 6s.

This volume is one of "Scottish Series of Junior Agricultural Textbooks" issued under the general editorship of Professor Hendrick. The series is intended for the use of intermediate agricultural students, attending a continuation course, extension lecture course or farm institute, more particularly those in Scotland and the North of England, where the agricultural conditions differ considerably from those in the south. The present book forms an excellent introduction to the study of what the author aptly terms the Farmer's Raw Materials and, if combined with a suitable practical course, should be of considerable service to the class of students for whom it is written. The relation between the composition of air and water and the nutrition of the plant is dealt with and then follow chapters on the formation of the soil, its composition and properties, micro-organisms of the soil, soil fertility and manuring, the valuation of manures, farmyard and other organic manures, nitrogenous, phosphatic and potash manures, and finally lime and liming.

INDIA OF TO-DAY. VOL. IV: INDIA'S MINERAL WEALTH. By J. Coggin Brown, O.B.E., D.Sc., F.G.S., etc. Superintendent, Geological Survey of India. Pp. 121, 7¼ × 5. (London: Humphrey Milford, 1923.) Price 3s.

This little book, by a well-known economic geologist, presents in a condensed and popular form the main facts known about the mineral resources of India. The arrangement is an alphabetical one, and upwards of 70 minerals are described in all. Those of considerable economic importance, such as bauxite, coal, gold, iron, lead, manganese, mica, petroleum and tungsten, are naturally dealt with at greater length than the remainder. An interesting account is given of the Indian oil-fields, including the early history of oil extraction at Yenangyaung, Burma, by the 24 families known as "Twinzayos." Interesting, too, are the accounts of the ruby mines of Mogok, Upper Burma, and of the aquamarines and sapphires of Kashmir.

The work may be recommended to all who wish to have concise and authentic information on the minerals of India. The references in the text should prove useful to the reader desirous of pursuing the subject in greater detail.

A Textbook of Petroleum Production Engineering. By L. C. Uren, Associate Professor of Petroleum Engineering, University of California. Pp. vii + 657, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1924.) Price 30*s*.

This work on oil production has been written from the point of view of the petroleum engineer, as distinct from the petroleum chemist and the petroleum geologist. About one-quarter of the book is devoted to the cable and hydraulic rotary drilling methods, the casing and fishing tools required and their manipulation. In the American standard cable system of drilling, the rig wheels, cables, and cordage, and, in the hydraulic rotary system, the manipulation of the rotary equipment, the circulating system and its control, and rotary core drilling and sampling devices, are more fully gone into than in most textbooks on petroleum. Diamond drilling, however, is somewhat scantily treated, considering that in recent years it has been successfully carried to depths exceeding 2,000 ft. In the chapter on oil-field hydrology the various methods of excluding water from oil and gas wells by means of packers, cement, mudding, etc., are fully discussed. One chapter is devoted to the control of high-pressure wells, and the methods adopted in capping "gushers" and dealing with fire. The various methods of pumping the oil—especially multiple pumping—are described in detail. Of special importance to the engineer are the chapters on the management of wells to secure maximum production, on power for oil-field purposes, and on the storage and transportation of petroleum. The last two chapters deal with auxiliary plants and departments, and with office methods and records.

The work is well written and illustrated, and should be particularly valuable to petroleum engineering students and also prove most useful to all engineers interested in petroleum production.

Standard Methods of Testing Petroleum and its Products. Pp. x + 102, 8½ × 5½. (London. The Institution of Petroleum Technologists, 1924.) Price 6*s*.

The increasing use of petroleum and its products in modern industry has led to the adoption, by different workers, of varied methods of analysis and testing. For obvious reasons it is desirable to secure uniformity in tests of this character, and in 1921 the Institution of Petroleum Technologists appointed a Standardisation Committee to deal with the matter. This Committee,

under the chairmanship of Mr. Alexander Duckham, included members of the Government departments principally concerned, and representatives of the chief industrial companies interested, together with a number of experts of recognised authority. Various sub-committees were also formed to deal with different classes of petroleum products.

The results of the deliberations of the Standardisation Committee have recently been published and form an extremely useful addition to the literature of petroleum testing. A selection of standard methods for the determination of the chemical and physical properties of petroleum and its products is given, and it may be hoped that the authoritative manner in which these methods are presented will lead to their general adoption.

It may be noted, in this connection, that the British Engineering Standards Association decided that they would adopt, for purposes of their specifications, whatever methods were standardised by the Institution of Petroleum Technologists.

An arrangement has been made with the National Physical Laboratory by which certain apparatus and instruments may be calibrated, tested, and marked as complying with the adopted standards.

Many of the methods recommended are those of the American Society for Testing Materials and the American Bureau of Standards, to whom due acknowledgment is made; but in the case of certain tests no departure is advised from the methods generally adopted in British practice.

THE CHEMISTRY AND PHYSICS OF CLAYS AND OTHER CERAMIC MATERIALS. By Alfred B. Searle. Pp. xiii + 695, 9½ × 7½. (London: Ernest Benn, Ltd., 1924.) Price 55*s*.

This somewhat imposing work is intended by the author "to provide, in a convenient form, such a description of the properties of various ceramic materials and articles, and of the application to them of the more important principles of chemistry and physics, as will be equally useful to students, manufacturers and users."

It is very doubtful whether it is wise to attempt, in one book, to cater for the requirements of these different classes. The student who has not progressed far beyond the elementary stage will find much that will be unintelligible to him, whilst the more advanced student may be irritated by the inclusion of a good deal of extremely elementary matter. It is surely unnecessary, for example,

in a specialised book of this nature, to endeavour to explain the meaning of ordinary chemical notation. Manufacturers, unless they have had a scientific training, will also find much of the book of little interest to them.

The work deals more or less fully with the chemical and physical properties of all the materials used in the ceramic industry and will no doubt prove of service to ceramic technologists.

MODERN WOOD-WORKING MACHINERY. By Stafford Ransome, M.Inst.C.E. Pp. xix + 385, 8½ × 5½. (London: William Rider & Son, Ltd., 1924.) Price 12*s*. 6*d*.

This interesting and useful volume will be of value to the wood-working industry in general and to those who contemplate installing wood-working machinery in particular.

Wood-converting machines of all descriptions are dealt with in a lucid and concise manner. The limitations of the various machines and the advantages of one type over another are discussed fully; and the characteristics of machinery manufactured in foreign countries are explained in comparison with those of British production.

The technical student would wish that the excellent photographs had been supplemented by more diagrams, as, in some cases, the functions of certain parts of a machine are necessarily obscure, where only a general view has been given; but the author has refrained from over-elaboration in technical matters, as he explains in his preface, from a desire to interest a wider circle of readers than merely saw-mill engineers.

LE RÉGIME DU TRAVAIL AU CONGO BELGE. By Th. Heyse, Docteur en Droit et en Sciences Politiques, sous-Directeur au Ministère des Colonies. Second Edition. Pp. viii + 248. (Bruxelles: Gœmaere, 1924.) Price 12 fr. 50 c.

This work is a comprehensive review of the laws and regulations affecting the relationship between master and man in the Belgian Congo.

In nine chapters the author deals very fully with the subject of labour contracts, their conditions, duration and termination, with the rights of the employer and employed and the means of enforcing their observance, with the recruiting of labour, hygiene, rations and all other considerations which would appear to be conducive to the general well-being of the native and to the satisfaction of the masters. The book possesses an excellent index and a large bibliography.

BOOKS RECEIVED

THE BRITISH EMPIRE: A SURVEY IN 12 VOLUMES, EACH SELF-CONTAINED. EDITED BY HUGH GUNN. VOL. I. THE DOMINIONS AND DEPENDENCIES OF THE EMPIRE. With a foreword by Field-Marshal H.R.H. The Duke of Connaught, K.G. Pp. xv + 423, 8¾ × 6. (London: W. Collins, Sons & Co., Ltd., 1924.) Price 16*s.*

THE BRITISH EMPIRE: A SURVEY IN 12 VOLUMES, EACH SELF-CONTAINED. EDITED BY HUGH GUNN. VOL. IV. THE RESOURCES OF THE EMPIRE AND THEIR DEVELOPMENT. By Evans Lewin, M.B.E. Pp. xvii + 364, 8¾ × 6. (London: W. Collins, Sons & Co., Ltd., 1924.) Price 16*s.*

THE BRITISH EMPIRE: A SURVEY IN 12 VOLUMES, EACH SELF-CONTAINED. EDITED BY HUGH GUNN. VOL. X. THE UNIVERSITIES AND EDUCATIONAL SYSTEMS OF THE BRITISH EMPIRE. By Arthur Percival Newton, M.A., D.Lit., B.Sc., F.S.A. Pp. xxiv + 282, 8¾ × 6. (London: W. Collins, Sons & Co., Ltd., 1924.) Price 16*s.*

HANDBOOK OF THE LEEWARD ISLANDS. Compiled by Frederick Henry Watkins, I.S.O. Pp. 308, 8½ × 5½. (London: The West India Committee, 1924.) Price 10*s.* 6*d.*

A GOLD COAST LIBRARY. By A. W. Cardinall, F.R.G.S., F.R.A.I. Pp. 36, 8½ × 5½. (London: Francis Edwards, 1924.) Price 1*s.*

THE VEGETATION AND SOILS OF AFRICA. By H. L. Shantz and C. F. Marbut. With a Section on the Land Classification of Africa by the joint authors, and a Note on a Rainfall Map of Africa by J. B. Kincer. American Geographical Society, Research Series No. 13, published jointly with the National Research Council. Pp. x + 263, 8 × 5, with 1 text map and 49 photographs; and with 2 maps in colour, each 36 by 33 inches, folded in separate case. Price $5·00.

SOIL MANAGEMENT. By Firman E. Bear. Pp. vi + 268, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1924.) Price 10*s.*

SOIL ACIDITY AND ITS RELATION TO THE PRODUCTION OF NITRATE AND AMMONIA IN WOODLAND SOILS. By G. R. Clarke, B.A., B.Sc. Pp. 27, 11 × 7½. (Oxford: The Clarendon Press, 1924.)

Logging: The Principles and General Methods of Operation in the United States. By Ralph Clement Bryant, F.E., M.A. Pp. xiii + 556, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 23*s.*

The American Lumber Industry. Embracing the Principal Features of the Resources, Production, Distribution, and Utilization of Lumber in the United States. By Nelson Courtlandt Brown, B.A., M.F. Pp. xviii + 279, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 15*s.*

Commercial Fruit and Vegetable Products. By W. V. Cruess. Pp. vii + 530, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1924.) Price 22*s.* 6*d.*

The Elements of Railroad Engineering. By William G. Raymond, C.E., LL.D., Eng.D. Pp. xxiv + 453, 8¾ × 5¾. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 22*s.* 6*d.*

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

ESSENTIAL OILS FROM VARIOUS PARTS OF THE EMPIRE

IN continuation of the reports on essential oils that have been published from time to time in this BULLETIN, an account is given in the following pages of the results of examination at the Imperial Institute of a number of essential oils and products yielding such oils which have been received from various parts of the Empire in recent years.

VETIVER ROOTS FROM THE GOLD COAST

The vetiver (khus khus) roots which are the subject of this report were exhibited at the International Rubber and Allied Products Exhibition held in London in 1921, and were subsequently transferred to the Imperial Institute for exhibition in the Gold Coast Court of the Public Galleries. The investigation was made in connection with a request from the Director of Agriculture for information regarding the demand for these roots and their probable value, in order that the question of cultivating the plants in the Gold Coast might be considered.

The material consisted of bundles of dried roots similar in appearance and odour to the vetiver roots of commerce.

On steam distillation the roots furnished 2·25 per cent. of a viscous, yellowish-brown oil having the characteristic persistent aroma of vetiver oil. The oil was found to have the following constants, which are shown in comparison with corresponding figures recorded (*a*) for oil

distill in Europe from dry imported vetiver roots, and (*b*) for the vetiver oil which is distilled from fresh roots in Réunion:

	Oil from Gold Coast roots.	European distilled vetiver oil.	Réunion vetiver oil.
Specific gravity at 15°/15° C.	1·021	1·014 to 1·042	0·982 to 1·020
Optical rotation a_D	+39·1°	+25° to +40°	+20° to +38°
Refractive index $n_{D\,20°C.}$	1·524	1·520 to 1·523	1·515 to 1·528
Acid value	23·4	25 to 65	4 to 20
Ester value before acetylation	7·9	10 to 25	5 to 20

These vetiver roots from the Gold Coast furnished a high yield of volatile oil, the results previously recorded for the roots from other sources being mostly below 1 per cent. The oil appeared to be of good quality and was similar in character to the commercial vetiver oil distilled in Europe.

Before the war the distillation of vetiver roots was carried on to some extent by firms in the United Kingdom, but at present most, if not all, of the oil used in this country is imported from Réunion and Java, the current prices varying from 20*s*. to 50*s*. per lb. in London. Essential oil distillers who were consulted by the Imperial Institute were of opinion that the roots might not be readily saleable here, as the material is very bulky and the cost of freight would therefore be excessive in view of the small percentage of oil present. They considered that the best method of ascertaining whether a profitable market could be found for the roots would be to forward a consignment of about 2 tons for trial sale.

General Conclusions

These vetiver roots from the Gold Coast are of good quality and give a large yield of oil, but it is uncertain whether a market can be found for them in the United Kingdom. Vetiver oil is now produced on a considerable scale in Réunion and Java, and little, if any, oil is being distilled in this country. It could not be recommended that the preparation of the oil should be attempted at present in the Gold Coast as it is a difficult operation to carry out. The only alternative would be to export the roots, but the demand for these is doubtful and the high cost of freight would be a serious disadvantage. In the circumstances it does not seem worth while to extend the

cultivation of vetiver roots in the Gold Coast, but it was pointed out to the Gold Coast authorities that if information could be furnished as to the quantity of roots which could be supplied from existing plants the Imperial Institute would ascertain whether any firm of essential oil distillers would purchase the consignment.

VETIVER ROOTS AND OIL FROM THE FEDERATED MALAY STATES

A sample of vetiver roots and two samples of oil were forwarded for examination to the Imperial Institute by the Agent, Malay States Information Agency, in 1923. It was stated that the first sample of oil had been dried by chemical means, whilst the second consisted of the original oil "after separation of as much as possible of the water mechanically."

Roots

The sample consisted of dried vetiver roots of the usual appearance and odour. On steam distillation they furnished 3·3 per cent. of a viscous, yellowish-brown oil, having the characteristic persistent aroma of vetiver oil.

Oil

(1) *Oil dried by chemical means.*—This consisted of viscid, dark greenish-brown vetiver oil of good aroma. It was examined with the following results, which are shown in comparison with corresponding figures recorded for (*a*) oil distilled in Europe from dry imported roots, and (*b*) oil distilled in Réunion:

	Present sample.	European distilled oil.	Oil distilled in Réunion.
Specific gravity at 15/15° C.	1·032	1·014 to 1·042	0·982 to 1·020
Optical rotation α_D	Too dark to read	+25° to +40°	+20° to +38°
Refractive index $n_{D20°}$	1·524	1·520 to 1·523	1·515 to 1·528
Acid value	35·5	25 to 65	4 to 20
Ester value before acetylation	11·8	10 to 25	5 to 20
Ester value after acetylation	162·0	130 to 160	120 to 150

These results show that the present sample of oil is of normal character.

(2) *Oil after separation of water mechanically.*—This oil was cloudy owing to the presence of water, some of which had collected on the surface. As regards aroma, however, it was equal to the chemically-dried sample described above. This oil could be rendered suitable for the market by filtration through paper.

The chemically-dried oil was regarded by experts as of good aroma, resembling in this respect Réunion vetiver oil rather than Indian. They considered that it would be worth 30*s.* per lb. ex-wharf London (January, 1924), but were of opinion that the price of vetiver oil might fall in the near future.

General Remarks

Roots.—The yield of oil, viz. 3·3 per cent., is much higher than the recorded figures for vetiver roots distilled in Europe, which range from 0·4 to a maximum of 2 per cent. As stated in connection with the sample of roots from the Gold Coast (p. 266), little if any vetiver oil is now distilled in the United Kingdom and it is therefore doubtful whether consignments of roots would find a market here.

Oil.—The oils received from Malaya and that distilled from the roots at the Imperial Institute were all of good marketable quality. The demand for vetiver oil, however, is not large, and supplies from the Federated Malay States would have to be offered in competition with the oil shipped from Réunion, Java and India.

It would appear unnecessary to dry the oil by chemical means, as after mechanical separation of the water so far as possible, the remainder can be removed by filtration through paper.

Inchi Grass Oil from India

A sample of inchi grass oil, received from the Director of Industries in Travancore was examined in order to ascertain whether the oil would be marketable in the United Kingdom and, if so, its probable commercial value.

Herbarium specimens of the grass stated to yield the

oil were submitted to the Royal Botanic Gardens, Kew, where the plant was identified as a large form of *Cymbopogon cæsius*, Stapf (=*Andropogon schœnanthus*, Linn., var. *cæsius*).

The sample was described as "Inchi grass oil; steam distilled September 15, 1920; dried at 105° C." It consisted of a clear yellowish-brown oil, with a geranium-like odour resembling that of a low-grade palmarosa oil.

The oil was examined at the Imperial Institute with the following results, which are shown in comparison with those obtained at the Indian Institute of Science, Bangalore, and with those recorded for palmarosa oil and ginger-grass oil:

	Inchi grass oil.		Palmarosa oil.	Ginger-grass oil.
	Present sample.	Sample examined at Bangalore.		
Specific gravity at 15/15° C.	0·924	0·9200	0·886 to 0·899	0·900 to 0·955
Optical rotation α_D.	− 39·85°	− 40°	− 3° to +5°	− 30° to +50°
Refractive index n_D.	1·486	1·4849	1·472 to 1·478	1·478 to 1·45
Acid value	1·0	0·03	0 to 3	2 to 6
Ester value, before acetylation	9·4	5·9*	12 to 50	8 to 40 (rarely 55)
Ester value, after acetylation	91·0†	98·4* ‡	225 to 270	120 to 200
Aldehydes (by bisulphite method), per cent.	3	4	—	—
Solubility in 70 per cent. alcohol	Insoluble	Insoluble in 3, 6, or 8 parts at 20° C.	Soluble in 3 vols.	Usually soluble in 3 vols., becoming cloudy on addition of more alcohol

* *Saponification values.*
† *Equivalent to 26·8 per cent. of geraniol.*
‡ *Equivalent to 29·2 per cent. of geraniol.*

The constants of the inchi grass oil, as determined at the Imperial Institute and at Bangalore, are in close agreement. They differ from those of palmarosa oil, which the inchi grass oil somewhat resembles in odour, and are more in accordance with those of ginger-grass oil.

This inchi grass oil differs in its constants from any of the grass oils of commerce. The oil might be employed as a substitute for palmarosa oil, but it would realise a considerably lower price than the ordinary grade of the

latter oil, which was quoted at 15*s.* 6*d.* to 17*s.* per lb. in London (February, 1922).

"TSAURI" GRASS FROM NIGERIA

During the investigation of Nigerian "tsauri" grass (*Cymbopogon giganteum*) at the Imperial Institute in 1921 as a paper-making material (see this BULLETIN, 1921, **19**, 275) it was noticed that the flower-heads have a characteristic aromatic odour. On distillation they yielded a volatile oil, and as several species of Cymbopogon yield oils of commercial value it was suggested to the Senior Conservator of Forests that a further quantity of the flowering grass should be forwarded in order that a detailed examination of the oil might be made and its value determined. A consignment of dried grass stems cut into lengths of about 2 ft. to 2 ft. 6 in. was subsequently received from Nigeria. The grass was generally similar in appearance to that previously received at the Imperial Institute, but it was thinner and contained a larger proportion of flower heads, these forming 32 per cent. of the total weight.

The separated flower-heads yielded on steam distillation 1·15 per cent. of volatile oil, whilst the grass as received, including stems, furnished only 0·45 per cent. The oil had a pleasant aromatic odour, somewhat resembling that of ginger-grass oil, but less intense.

The oil was examined with the following results, which are shown in comparison with the range of corresponding figures recorded for ginger-grass oil:

	Present sample	Ginger-grass oil.
Specific gravity at 15°/15° C.	0·950	0·900 to 0·955
Optical rotation $\alpha_{D\,20°}$	− 42·65°	− 30° to +50°
Refractive index $n_{D\,20°}$	1·493	1·478 to 1·495
Acid value	5·8	2 to 6
Ester value, before acetylation	9·7	8 to 40
Ester value, after acetylation	194·0*	120 to 200
Aldehydes, per cent †	10·0	—
Solubility in 70 per cent. alcohol	Soluble in 2 or more vols.	Usually soluble in 3 vols., becoming cloudy with a larger quantity

* *Equivalent to 62·4 per cent. of total alcohols, calculated as* $C_{10}H_{18}O$.

† *Determined by the neutral sulphite method.*

These results show that the constants of the oil are similar to those of ginger-grass oil.

The oil was considered by experts to compare unfavourably with ginger-grass oil, and it would probably only find a market at a price below that of the latter oil for use as a cheap perfume for soap. Ginger-grass oil was realising about *8s. 6d.* per lb. in London at the date this oil was examined (January, 1923), but on account of the high price the demand was small and it was considered that in order to market the oil in large quantities it would have to be offered at not more than *4s.* to *5s.* per lb.

The results of this investigation show that the flower-heads of "tsauri" grass contain about 1 per cent. of an aromatic volatile oil somewhat resembling ginger-grass oil in character but of inferior quality. It is doubtful whether the oil would find a market in the United Kingdom at a remunerative price in competition with ginger-grass oil, and in any case it would not be feasible to ship the flower-heads to this country for distillation. The oil would therefore have to be prepared in Nigeria and in view of its comparatively low value this course could not be recommended.

PATCHOULI OIL FROM SEYCHELLES

Four samples of patchouli oil from Seychelles have been examined in recent years.

No. 1.—This oil was somewhat cloudy owing to the presence of moisture. The clear filtered oil, which was greenish-brown, was rather more limpid and had a less intense odour than some of the samples of patchouli oil previously examined at the Imperial Institute. The constants of the oil are shown in the table on p. 272 in comparison with corresponding figures recorded for imported Singapore patchouli oil and for oil distilled in Europe from imported Singapore leaves.

The oil had a good though not very intense aroma, and was of fairly satisfactory colour. Its constants resembled those of imported Singapore oils but the solubility and the specific gravity were rather low. The approximate value of the oil in London was *32s. 6d.* per lb. (July, 1922).

Results of Examination of Patchouli Oils.

	Seychelles oils.				Singapore oils.	
	No. 1.	No. 2.	No. 3.	No. 4.	Imported oil.	Distilled in Europe from imported leaves.
Specific gravity at 15/15° C.	0·9560	0·9484	0·969	0·940	0·955 to 0·980	0·965 to 0·995
Optical rotation $\alpha_{D\ 20°\ C.}$	−47·56°	−51·8°	*	*	−44° to −62°	−50° to −68°
Refractive index $n_{D\ 20°\ C.}$	1·5075	1·5075	1·509	1·502	1·506 to 1·513	1·506 to 1·513
Acid value	2·0	1·3	†	3·2	0 to 1	1 to 5
Ester value	3·0	nil	†	5·3	1·5 to 8	2 to 12
Solubility in 90 per cent. alcohol at 15° C.	Not entirely soluble even in 11 vols.	Not completely soluble even in 12 vols.	Soluble in 0·5 vols.	Soluble in 6·5 vols.	Soluble in 3 to 10 vols.	Mostly soluble in 1 to 2 vols.

* *Indeterminable owing to dark colour of the oil.*
† *Not determined.*

No. 2.—This consisted of clear greenish-yellow patchouli oil, with the characteristic odour of that product.

The results of examination of the oil are given in the table above.

The oil was superior in aroma and colour to Sample No. 1, but otherwise it resembled the latter oil except as regards specific gravity, which is somewhat lower. In this respect it more nearly approached the patchouli oil which is obtained in Java.

Patchouli oil of this quality would be readily saleable in the United Kingdom, and a firm of manufacturers consulted by the Imperial Institute considered it to be worth 28*s*. per lb. (July, 1923).

No. 3.—This sample was labelled "Patchouli, Penang, Barbarona Estate." It consisted of patchouli oil containing a small amount of dirt and moisture which rendered it cloudy. The clear filtered oil was greenish-brown. The oil possessed a peculiar subsidiary odour in addition to the intense characteristic odour of patchouli.

The results of the examination of the oil at the Imperial Institute are shown in the above table.

The oil was unusually soluble in 90 per cent. alcohol for a genuine patchouli oil, and its odour was quite distinct

from that of the previous samples from Seychelles examined at the Imperial Institute.

Importers and manufacturers who were consulted regarded the sample as much inferior to the best commercial grades of patchouli oil. The general view expressed was that owing to its unusual odour and dark colour the oil would be difficult to dispose of in this country, and that in any case it would have to be offered at a price considerably lower than that of commercial Singapore or Penang patchouli oils, which in September, 1923, were quoted at from 27*s*. to 30*s*. per lb. in London.

No. 4.—This oil had been obtained by the distillation of dry leaves, and it was desired to ascertain its quality in comparison with that of oil distilled from fresh leaves.

The sample, which was described as "Essence de Patchouli Penang, Feuilles sèches," consisted of a clear green oil, which had the characteristic odour of patchouli but was rather more limpid than the ordinary patchouli oil of commerce.

The constants of this oil as determined at the Imperial Institute are given in the table on p. 272.

This oil, prepared from dry leaves, was much less soluble in alcohol than the oil distilled from fresh leaves (No. 3) but was considerably paler and of better odour. It possessed to some extent the peculiar subsidiary odour noticed in Sample No. 3, and this would render it of lower commercial value than Penang and Singapore oils, the ordinary qualities of which were realising 24*s*. 6*d*. per lb. in the United Kingdom in November, 1923.

Cinnamon Leaf Oil from Seychelles

Cinnamon ("canelle") leaf oil is a regular article of export from the Seychelles, the quantities in litres shipped in recent years being as follows: 1918, 12,700; 1919, 24,400; 1920, 39,500; 1921, 29,000; 1922, 43,366.

A sample of the oil was forwarded to the Imperial Institute in 1922, in order that its quality and commercial value might be determined.

The oil was somewhat cloudy owing to the presence of water. The clear filtered oil was reddish-brown and

had a satisfactory odour. It was found to have the following constants, which are shown in comparison with those of samples of Seychelles cinnamon leaf oil previously examined at the Imperial Institute and for commercial cinnamon leaf oil:

	Present sample.	Previous samples.	Commercial cinnamon leaf oil.
Specific gravity at 15/15° C.	1·0488	1·046 to 1·060	1·043 to 1·066
Optical rotation α_D 20° C.	−2·06°	−1·2° to −1·45°	−0·16° to +2·63
Refractive index n_D 20° C.	1·533	1·533 to 1·539	1·530 to 1·540
Eugenol . . . *per cent.*	86	86 to 92·5	70 to 95
Aldehydes (by the bisulphite method) . . . *per cent.*	3·0	0·5 to 2·5	0 to 3
Solubility in 70 per cent. alcohol at 15° C.	Soluble in 1·5 vols. No turbidity on further dilution	Soluble in from 1·1 to 1·3 vols., with no turbidity on further dilution	Soluble in 2 to 3 vols., becoming turbid on further dilution

The above results show that the present sample contained a fairly high percentage of eugenol, and was generally similar in quality to the Seychelles cinnamon leaf oils previously examined at the Imperial Institute. It was regarded in the trade as being worth approximately 5*s*. 4*d*. per lb. in London in July, 1922.

Thyme Oil from Cyprus

The sample of thyme oil from Cyprus which is the subject of this report was forwarded to the Imperial Institute by the Director of Agriculture in 1922. The oil was stated to have been distilled from the native thyme bush at Kornos, Larnaca District, and it was desired to ascertain its quality and commercial value.

The sample consisted of a clear, reddish-brown oil resembling the ordinary "red" thyme oil of commerce. It was found to have the following constants, which are shown in comparison with corresponding figures recorded for commercial thyme oils of French and Spanish origin:

	Present sample.	French thyme oil.	Spanish thyme oil.
Specific gravity at 15/15° C.	0·933	0·905 to 0·935	0·928 to 0·958
Optical rotation α_D	−0·65°	−0·5° to −4°	+2° to −4°
Refractive index n_D 20° C.	1·502	1·480 to 1·495	1·502 to 1·511
Phenols . . . *per cent.*	49·5	20 to 40	50 to 75

From the phenols, when well cooled, 74 per cent. of crystalline thymol was separated, equivalent to 36·5 per cent. of thymol from the original oil. In containing a preponderance of thymol, the phenols resemble those of French thyme oil and differ from those of Spanish thyme oil in which carvacrol usually predominates.

The oil was regarded in the trade as worth about 4*s.* to 5*s.* 6*d.* per lb. in London, when thymol was quoted at approximately 10*s.* per lb. (April, 1923). It was pointed out, however, that thymol is now being produced synthetically and that this fact might in future affect the price obtainable for consignments of thyme oil.

The investigation has shown that the oil contains a fairly high percentage of phenols consisting mainly of thymol. The oil should be readily marketable in the United Kingdom, and it was indicated to the Cyprus authorities that if a trial consignment could be forwarded to test the market the Imperial Institute would be glad to arrange for its sale in London.

Leaves of *Ocimum gratissimum* from Seychelles

In 1913 Roure-Bertrand Fils (*Bulletin*, Oct., 1913, p. 17) reported on the examination of a sample of volatile oil stated to be derived from *Ocimum gratissimum.* This oil, which was prepared at Dabakala, West Africa, resembled ajowan seed oil in odour and contained 44 per cent. of phenols consisting almost entirely of thymol.

A small sample of oil was received at the Imperial Institute from the Curator of the Botanic Station, Seychelles, in 1917, together with herbarium specimens of the plant from which it had been distilled. It was stated that the plant grows as a common weed on the roadsides in Mahé, and that the green leaves had furnished 0·1 per cent. of volatile oil. The plant was identified at Kew as *Ocimum gratissimum*, Linn. The leaves and oil possessed a pronounced odour of cloves, showing clearly that the oil differed in character from the West African oil mentioned above.

The oil as received was pale brown and had the following constants:—Specific gravity at 15/15° C. 0·995,

optical rotation $a_D - 14{\cdot}0°$, refractive index $n_{D20°}$ 1·526. It contained 62 per cent. of phenols.

A larger sample of the oil was received from Seychelles in 1919 and it had the following characters:—Specific gravity at 15/15° C. 0·996, optical rotation $a_D - 12{\cdot}7°$, refractive index, $n_{D20°}$ 1·532. The oil contained 55 per cent. of phenols.

The latter sample of oil was submitted to detailed examination at the Imperial Institute and the results have been published in a paper by O. D. Roberts, F.I.C., of the Scientific and Technical Department, in *Journ. Soc. Chem. Ind.* (1921, **40**, 164T).

The results showed that the oil had the following approximate composition:

	Per cent.
Terpenes, chiefly or entirely ocimene	16·0
Phenols, eugenol	55·0
Phenol ethers, calculated as methylchavicole	5·6
Alcohols, probably linalool	13·0
Esters (calculated as $C_{10}H_{17}OH$)	0·6
Residue and loss (by difference)	9·8

Reference may be made to the volatile oil derived from the leaves of a large-leaf variety of *Ocimum Basilicum*, Linn., stated to be known in Java as "Selasih Mekah." This oil was examined by P. van Romburgh (*Proc. K. Akad. Wetensch.*, 1900, p. 446) and appears to be rather similar in composition to the present sample of oil. Different samples of these leaves furnished from 0·18 to 0·32 per cent. of volatile oil, having specific gravity at 26° C. 0·890—0·940, optical rotation $a_D - 11{\cdot}25°$ to $-18°$. The oil contained from 30 to 46 per cent. of eugenol, and also the terpene ocimene.

Schimmel & Co. (*Report*, 1908, April, 123) have also recorded the results of the examination of a volatile oil obtained from an unidentified species of *Ocimum* found in the island of Mayotte, which had the following characters: specific gravity at 15/15° C. 0·9607, optical rotation $a_D - 14°54'$. This oil also contained eugenol 38 per cent., and had, moreover, the odour of methylchavicole.

FRUITS OF *Ocimum americanum* FROM SOUTH AFRICA

A sample of fruits, described as "seed capsules of *Ocimum americanum* collected on the farm Roodekop 509 in the Elands River Ward, Pretoria district," was received in May, 1921. It was stated that the plant grows in abundance in the wild state on the farm mentioned, and it was desired to ascertain whether it would be of value as a source of thymol or other constituent.

The sample consisted of small, dried, brown seed-capsules, containing very small black seeds. The material had a strong but not unpleasant aromatic odour.

On distillation with steam the fruits furnished 1·0 per cent. of a colourless volatile oil, with a characteristic and somewhat anise-like odour. The oil had the following constants:

Specific gravity at 15/15° C.	0·953
Optical rotation $\alpha_{D\,24°C.}$	+ 2·75°
Refractive index $n_{D\,24°C.}$	1·511

The amount of phenols in the oil was practically negligible, and therefore no appreciable amount of thymol was present.

The quantity of oil obtained from this small sample of fruits was insufficient for detailed investigation, but the oil apparently contained no thymol and thus differed from that of *Ocimum viride*, samples of which examined at the Imperial Institute have been found to contain from 32 to 65 per cent. of this constituent.

The oil does not possess an attractive odour and its commercial possibilities are not promising. In order, however, that it may be fully investigated and its composition ascertained it has been suggested that a consignment of about 1 cwt. of the dried fruits should be forwarded to the Imperial Institute.

HUON PINE OIL FROM TASMANIA

The sample of Huon pine oil (*Dacrydium Franklini*, Hook. f.) which is the subject of this report was forwarded

to the Imperial Institute by the Acting Director of Agriculture, Tasmania, in February 1919. It was labelled "Extract of Huon Pine, distilled by Lottah Eucalyptus Oil Co., Dover, Tasmania," and consisted of a pale straw-coloured oil having an odour of methyl-eugenol.

The oil was submitted to examination at the Imperial Institute and the results are shown in the following table in comparison with the figures previously recorded for Huon pine oil :—

	Present sample.	Figures previously recorded for Huon pine oil. (1)	(2)
Specific gravity at 15/15° C.	1·040	1·035	1·044
Optical rotation α_D	−3·75°	+1·4°	+0·1°
Refractive index n_D	1·533	1·5373	1·5328
Acid value	0·8	3·1	0·9
Ester value before acetylation	0·9		1·5
Ester value after acetylation	11·2	—	—
Solubility in 70 per cent. alcohol	Soluble in 1·5 vols.	—	—

On distillation about 90 per cent. of the oil passed over between 250° and 253° C. under 755 mm. pressure, and consisted essentially of methyl-eugenol.

The Imperial Institute made enquiries as to the possible commercial value of this oil, and two firms of essential oil distillers, who examined samples, expressed favourable opinions regarding it. It is, however, difficult to estimate the commercial value of the oil, and it has been suggested that the best method of determining this would be to ship a substantial consignment (about 5 cwts.) to this country in order to test the market. If this met with a ready sale there would probably be no difficulty in disposing of considerable quantities.

The results of the investigation show that the composition of the present sample of Huon pine oil agreed with that recorded for the oil by previous observers. Methyl-eugenol is used to some extent in perfumery, but no regular demand has hitherto arisen for Huon pine oil although it is clear from the results of the enquiries made by the Imperial Institute that there is likely to be a demand for it if it can be supplied in commercial quantities and at a reasonable price.

Tagetes minuta Oil from South Africa

A sample of oil distilled from *Tagetes minuta* in South Africa was forwarded to the Imperial Institute by the Chief, Division of Botany, in June, 1923. It was stated that the plant, which is a troublesome weed, yields 0·5 per cent. of volatile oil, and it was desired to ascertain whether it would be of commercial value.

The oil was rather dark brown in colour and had a characteristic but not very pleasant odour. It was cloudy owing to the presence of extraneous matter, some of which had been deposited at the bottom of the liquid.

The clear filtered oil was found to have the following constants:

Specific gravity at 15/15° C.	0·9369
Optical rotation α_D .	+1·7°
Refractive index $n_{D20°}$.	1·496
Acid value . . .	1·5
Ester value before acetylation	44·5
Ester value after acetylation	116·5*
Solubility in 90 per cent. alcohol	Soluble in 1·5 parts and less (at 15° C.), becoming cloudy on further dilution

* *Equivalent to* 35 *per cent. total alcohols, expressed as* $C_{10}H_{18}O$.

Owing to its dark colour and to the fact that it was found to be rather sticky on handling, the oil was re-distilled with steam, when it yielded only 55 per cent. of pale yellow oil, leaving a solid, fairly hard, brittle resinous residue. Although kept in a sealed flask this pale yellow oil slowly darkened in colour and a portion of it which was distilled again a month later furnished a further quantity of resin, amounting to 20 per cent. of the weight of the re-distilled oil. The oil received from South Africa therefore contained a considerable amount of a compound which readily polymerises, or of some easily decomposable material.

The results of a detailed examination of the oil re-distilled at the Imperial Institute showed that the characteristic odour is largely due to the presence of carvone, linalool and an olefinic terpene, either myrcene or ocimene. Linalyl acetate is also probably present, to-

gether with small amounts of pungent-smelling phenols. Linalool and carvone, the only constituents likely to be of any commercial interest, were not present in sufficient quantity to be worth extraction.

Tagetes minuta oil could only be utilised for soap perfumery, but would be of little value for this purpose as it readily resinifies and darkens in colour on keeping, and its odour is not attractive. In view of these facts and the low yield of the oil it would not be profitable to collect and distil the plant on a commercial scale.

THE COOLIBAH TIMBER OF WESTERN AUSTRALIA

In connection with the investigation of Empire timbers which is being undertaken at the Imperial Institute in association with the Advisory Committee on Timbers, the mechanical properties of coolibah timber from Western Australia have been ascertained and a preliminary enquiry has been carried out as to the purposes for which the timber could be utilised.

Coolibah (*Eucalyptus microtheca*, F.v.M.) according to Maiden (*A Critical Revision of the Genus Eucalyptus*, Vol. II, 1914, p. 52) is found in the drier parts of Australia, in all the mainland States except Victoria. It usually occurs on the banks of rivers or in depressions liable to flooding. The name "coolibah" or "coolabah" appears to be general throughout the regions where the tree occurs; other names for the tree are dwarf box and swamp box in New South Wales, flooded box in Queensland, and flooded gum and black-heart gum in Western Australia. The timber is said to be largely used in some parts for fencing purposes and lasts well in the ground.

Coolibah timber is available in considerable quantities in Western Australia, according to a statement furnished to the Imperial Institute by the Acting Conservator of Forests in that State, the amount available within 30 miles of Wyndham being in the neighbourhood of 20,000 tons. It has been used for bearings in machinery, for the teeth of cog wheels, and tail-shaft bearings, and has

been experimented with for the manufacture of bowling balls. The height of the tree overall in Western Australia is given as 25 to 35 ft., the average length of the bole to the first limb being 8 to 12 ft., but in New South Wales it is said to attain a height of 70 to 80 ft., with a diameter of 4 ft.

The specimens received at the Imperial Institute for examination consisted of two logs 6 ft. long and approximately 16 in. in diameter.

The bark was intact, firmly attached to the wood, fairly hard and about $\frac{3}{4}$ in. thick; the outer layers were dark greyish-brown, whilst the inner layers, which peeled off in long wavy strips, were pinkish-brown. Occasional deposits of resinous material were found between these layers.

The heartwood was dark brown and the sapwood light greyish-brown with undulating orange bands. The wood was in sound condition, free from knots and fungus, but showed several large cracks. The grain was interlocked and alternating spiral, moderately fine, short-fibred, dense and compact, and cold to the touch.

In *transverse section* the wood was dark brown with very numerous, evenly distributed, minute pores with white resinous contents. The rays were seen with the aid of a magnifying glass as fine, light lines, very numerous and densely distributed. The rings, about 8 to the inch, were ill-defined, being indicated by a darker brown boundary.

In *radial section* the wood was of a lighter shade, the alternating spiral grain being clearly shown by the alterations in shading. The pores were well defined, white lines, their variations showing the wavy nature of the grain; with the aid of a magnifying glass the rays were seen as small groups of very fine, white lines. The rings were indicated by narrow, dark bands.

In *tangential section* the wood was slightly darker than in the radial section, and the pores were seen as clearly defined, white, undulating lines. The rays were very fine, numerous, light-coloured lines; the rings were indicated by the darker shading corresponding to the boundaries.

Summary of Results of the Mechanical Tests on "Coolibah" Timber

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading).*				
Maximum calculated longitudinal shear	*lb./sq. in.*	584	456	517
Modulus of rupture	"	16,250	12,400	14,310
Fibre stress at elastic limit	"	12,880	10,890	11,940
Modulus of elasticity	"	1,775,000	1,642,000	1,680,000
Elastic resilience	*inch-lb./cu. in.*	5·24	3·50	4·45
B.—*Compression test along the grain (24 in. length specimen).*				
Crushing length	*lb./sq. in.*	10,060	9,150	9,410
Fibre strength at elastic limit	"	7,500	6,410	6,925
Modulus of elasticity	"	2,261,000	1,655,000	1,638,000
Elastic resilience	*inch-lb./cu. in.*	12·98	10·13	11·58
C.—*Compression test along the grain (8 in. length specimen)*				
Crushing strength	*lb./sq. in.*	10,920	10,160	10,460
Fibre strength at elastic limit	"	9,140	7,680	8,491
Modulus of elasticity	"	1,840,000	1,330,000	1,531,000
Elastic resilience	*inch-lb./cu. in.*	20·55	17·03	18·45
D.—*Compression test across the grain.*				
Load at elastic limit	*lb.*	24,740	20,630	23,020
Fibre stress at elastic limit	*lb./sq. in.*	6,160	8,280	5,788
E.—*Shearing tests along the grain.*				
Radial—				
Maximum load supported	*lb.*	11,560	9,720	10,710
Shearing strength	*lb./sq. in.*	2,930	2,465	2,710
Tangential—				
Maximum load supported	*lb.*	13,950	11,680	12,860
Shearing strength	*lb./sq. in.*	3,460	2,860	3,330
Specific gravity		1·463	1·336	1·432
Weight per cubic foot	*lb.*	91·4	83·5	89·5
Moisture	*per cent.*	16·07	9·99	12·65

Results of Working Tests

Sawing.—The wood is difficult to cut with hand saws, and the teeth of power saws are soon blunted.

Planing.—Planes scrape the radial surface and slide over the tangential surface. The iron requires setting at a greater angle than usual to the surface to be cut and it is then possible to scrape in either direction, but the wood "picks up" very badly.

Boring.—Centre bits are very hard to use as they heat up and barely cut; gimlets and bradawls are useless. Morse twist drills give clean holes, but tend to bind and heat up.

Nailing and screwing.—Nails bend over and the wood

tends to split. Screws can be used if holes are drilled to the diameter of the core of the screw.

Mortising and dovetailing.—The wood can be cut, but with difficulty, in a mortising machine; there is a tendency to split. Strong joints are obtainable.

Working with gouge and chisel.—The wood is tough to work but moderately good results are obtainable; there is a tendency to splinter.

Turning.—The wood is tough but good results are obtainable; a smooth surface can be obtained with hand tools alone, and a polished finish with sand-paper. Flanges are fairly strong and resilient.

Glueing.—Strong joints are obtainable as the wood absorbs glue fairly well.

Polishing.—A liberal application of polish is necessary, otherwise the surface soon becomes dull.

Varnishing.—The wood takes varnish satisfactorily.

Remarks

Coolibah is an extremely hard, tough and heavy wood. Its resistance to crushing and shearing is exceptionally high and its bending strength is fairly good.

In the hardness tests it was found that the tangential surface gave the maximum resistance to penetration, whilst the radial and end surfaces were approximately equal in this respect. The hardness of the wood was, however, fairly uniform.

The specific gravity of the wood is also uniform, as in the thirty-six test pieces used there was only a variation of approximately 9 per cent. between the highest and lowest values.

The wood is very difficult to work with hand or power tools; hand planing is the most troublesome (on account of the extreme hardness and "picking up") and turning is relatively the easiest. With care, an excellent polished surface and finish can be obtained.

Specimens of the timber were submitted to the Imperial Institute Advisory Committee on Timbers for their opinion as to the purposes for which it could be utilised and its commercial possibilities. The Committee considered that

the uses of Coolibah in this country would be strictly limited on account of its weight and hardness, but that it might be found suitable as a substitute for lignum vitæ for certain purposes. At the suggestion of the Committee enquiries were made as to whether Coolibah would be likely to be accepted as a substitute for lignum vitæ for constructing the lining of propeller-shaft tubes. The results, however, were not promising.

Careful seasoning of the wood would appear to be essential as, in a considerable proportion of the samples examined, the wood "checked" readily in a warm, dry atmosphere. This "checking," if a constant feature of the wood, would be a serious disadvantage to the use of Coolibah as a substitute for lignum vitæ. In this connection the Conservator of Forests has informed the Institute that timber buried in sawdust and stacked under cover for about twelve months remained perfectly sound, no checking whatever taking place.

BAKING QUALITIES OF MESOPOTAMIAN WHEAT

An account of the methods of cultivation of wheat in Mesopotamia (Iraq), and of selection experiments carried out by the Department of Agriculture at the Experimental Farm at Bagdad, has been given in this Bulletin (1920, **18**, 544). In September, 1923, seventeen samples of wheat, including both local and introduced varieties, grown at the Government Experimental Farm, were sent to the Imperial Institute for examination, more particularly with a view to determining the baking qualities of the different kinds. The chemical examination of the wheats was conducted in the laboratories of the Institute and milling and baking tests were carried out at the request of the Institute by Mr. John Kirkland, of the National School of Bakery, Borough Polytechnic, London.

The samples, which weighed about 60 lb. each, were as follows:

No. 6. Durum leucurum (Iraq).—Clean, good condition, medium-sized grains, mostly very hard, light brown, translucent; a fair number of opaque white grains.

No. 9. *Durum leucomelan* (Iraq).—Clean, good condition, large grains; otherwise similar to No. 6.

No. 36. *Durum obscurum,* "Black Don" (Germany). —Clean, good condition, medium-sized grains, very hard; partly brown, translucent; and partly white, opaque; chiefly the latter.

No. 39. *Durum libycum* (Iraq).—Mostly translucent; otherwise similar to No. 36.

No. 59. *Vulgare erythrospermum,* "King's Red" (Australia).—Clean, good condition, medium-sized grains of medium hardness; light brown, partly translucent and partly opaque.

No. 113. *Vulgare albidum,* "Clarendon" (Australia). —Rather earthy condition; small to medium-sized, moderately hard grains of light colour and semi-translucent; sweetish taste.

No. 115. *Vulgare albidum,* "Comeback" (Australia). —Rather earthy condition; rather small, hard grains; mostly light brown and translucent; some with white opaque portions; some very small green grains present.

No. 153. *Vulgare albidum,* "Central Provinces No. 65" (India).—Clean, good condition, small to medium-sized grains of medium hardness; light-coloured and semi-translucent to white and opaque.

No. 158. *Vulgare albidum.*—Clean, good condition, small to medium-sized grains of moderate hardness; light brown and semi-translucent to white and opaque.

No. 178. *Vulgare alborubrum,* "Canberra" (Australia). —Rather earthy condition, medium-sized, moderately hard grains; light brown, semi-translucent.

No. 187. *Vulgare alborubrum,* "Hard Federation" (Australia).—Slightly earthy condition, small to medium, fairly hard; light brown, translucent to semi-translucent, some showing opaque white patches.

No. 192. *Vulgare alborubrum,* "Redwing" (Australia).—Slightly earthy condition, small to medium-sized hard grains; light brown, translucent to semi-translucent, some showing opaque patches.

No. 204. *Vulgare pyrothrix,* "Central Provinces No. 122" (India).—Clean, good condition, small to medium-

sized, hard; light brown, mostly translucent, some showing opaque patches.

No. 24. Durum hordieforme (Iraq).—Clean, good condition, large, long grains; mostly very hard, light brown and translucent; others only moderately hard, white and opaque.

No. 31. Durum alexandrinum (Iraq).—Clean, good condition, medium to large, very hard; brown and translucent, some showing opaque portions.

No. 222. Vulgare erythroleucon (Iraq).—Clean, good condition, small, very hard; light-coloured and translucent.

No. 243. Vulgare pyrothrix (Iraq).—Clean, good condition; mostly small grains similar to No. 222; some with opaque portions of moderate hardness.

Results of Chemical Examination

The following table shows the results of the chemical examination of the seventeen wheats at the Imperial Institute. The figures are expressed in each case on the wheat as received.

Sample No.	Moisture. *Per cent.*	Proteins. (N × 5·7) *Per cent.*	Gluten. Wet. *Per cent.*	Gluten. Dry. *Per cent.*
6	9·7	10·2	26·5	10·4
9	9·6	9·6	24·1	8·9
36	9·4	10·1	17·8	6·3
39	10·2	10·0	23·5	8·3
59	9·9	11·1	28·3	9·1
113	9·3	11·5	29·8	10·5
115	9·5	12·0	24·5	9·3
153	9·8	9·0	19·7	6·8
158	9·5	10·3	25·2	8·9
178	10·0	9·5	23·9	8·4
187	9·6	9·5	20·0	7·1
192	9·8	9·9	20·9	7·6
204	9·4	9·6	22·8	8·3
24	8·6	11·0	25·5	9·3
31	8·8	12·3	29·2	10·2
222	8·7	11·0	25·1	8·3
243	8·6	9·9	21·7	7·7

The six Durum wheats (Nos. 6, 9, 36, 39, 24 and 31) contain low percentages of gluten for wheats of this type. Sample No. 36, grown from seed of German origin, contains the least gluten, i.e. only 6·3 per cent., whilst the

gluten in the five other Durum wheats, grown from Iraq seed, varies from 8·3 to 10·4 per cent. European and American-grown Durum wheats usually contain over 12 per cent. It would thus appear that under Iraq conditions wheat normally of high gluten content may become modified in this respect. The amount of protein in the six samples was also low for Durum wheat.

These Durum samples were, on the whole, of characteristic hardness and translucency, but, as indicated in the above descriptions, grains of a starchy, opaque character, unlike ordinary Durum grains, were also present to a varying extent. Nos. 6, 36 and 39, moreover, did not exhibit the large grains usually characterising Durum wheats, but this is not a disadvantage, as millers prefer very hard wheats to have small grains.

With regard to the Vulgare wheats, those of Australian origin contain from 7·1 to 10·5 per cent. of gluten; these figures, and also the percentages of proteins, are normal for Australian-grown Vulgare wheats. The two Vulgare wheats of Indian origin yielded 6·8 and 8·3 per cent. of gluten; in general Indian wheats with less than 8 per cent. of gluten are considered low in this respect.

Results of Baking Trials

The following report on the character of the flours which the wheats yielded was furnished by the baking expert, Mr. John Kirkland.

No. 6.—" Produces a small loaf. Flour is quite stable, but does not bear long fermentation. Very suitable for short straight doughs. Good as part mixture with tougher variety."

No. 9.—" Produces small loaf, but plump. Not suitable for long process doughs, but excellent for short doughs, in cases where much bulk is not desired. Good wheat to form part of mixture with stronger variety. The flour from this was not tough."

No. 36.—" Small loaf, but quite plump and bold, as if flour stable, but not springy. It is of rather the 'stodgy' class. Behaves in dough, and produces bread, not unlike

that from English wheat. Would not be very suitable alone for bread-making purposes, if fermentation employed, but useful for chemically aerated goods, or would serve as part mixture with stronger flour."

No. 39.—" This flour soft, with tendency to be 'runny.' Loaf flat and poor in appearance, as if flour wanting in springiness, and unable to bear effects of fermentation. Would not be suitable for bread-making alone."

No. 59.—" Made rather small loaf. Flour belongs to soft variety, but quite stable. Would not be very satisfactory to use alone in fermented bread. Would serve as part mixture with stronger wheat."

No. 113.—" This flour produces a full-sized loaf. It is evidently stable, and will bear full measure of fermentation. It could be used alone in a short dough process ; or as part of mixture with one of the softer wheats."

No. 115.—" This makes strong flour, which, sufficiently fermented, produces large and shapely loaf. The flour is stable. May be used for 'short' or 'long' straight dough, but, if the former, with extra yeast, or some softening agent. Would form part of good mixture with softer wheat."

No. 153.—" Flour from this wheat is stable and strong. Fermented sufficiently it produces loaf of large volume and plumpness. Would be most profitably employed in long process bread-making. Not very suitable for any process of straight dough by itself, under 8 or 9 hours in bulk. But could rightly be diluted with some softer variety of wheat."

No. 158.—" Belongs to strong variety. Stable and requires to be well fermented. Produces loaf of moderate size. Suitable to use alone in straight dough, allowed to stand about 5 hours in bulk."

No. 178.—" Rather soft flour, with tendency to be 'runny.' Loaf small. Crust much cracked, as if flour starchy and gluten unstable."

No. 187.—" Gluten of this flour tough and stable. Dough properly ripened makes large loaf. Suitable for bread-making without mixture, on a short dough process."

No. 192.—" This flour not very springy. Stodgy but

stable. Makes small loaf. Better be fermented on a short process, and, to be quite satisfactory, from the baker's point of view, would need a small admixture of stronger flour."

No. 204.—" This is a strong flour, but with a slight tendency to flatten in dough. Would not suit bread-making by itself, but gives excellent results if mixed with proportion of softer but stable flour. Makes a large loaf used alone."

No. 24.—" Made a small loaf. Close in texture. Flour would only suit short straight dough method of fermentation, and then only if large volume bread is not required. Flour was quite stable, and loaf had plump appearance."

No. 31.—" Moderate strength, flour very stable. Produces loaf of quite normal bulk. Close in texture. Readily acquires colour on crust. Could be used on a short process system by itself. Will not bear long fermentation."

No. 222.—" Makes large excellent loaf. This is evidently a mild softish wheat, and could be used alone to make bread on a straight dough system, about 4 hours fermenting in bulk."

No. 243.—" Small, rather poor loaf. Flour seems to have little spring in it. Would not suit very well as a bread-making flour by itself. Has a tendency to 'runniness,' but might serve as diluent of strong flour."

In connection with these observations Mr. Kirkland furnished explanations of certain of the technical terms employed, and in view of the general interest of his memorandum it is printed as an Appendix to this report.

Commercial Value

As a result of his tests, Mr. Kirkland stated that all the wheats should be saleable in the United Kingdom, at prices comparable with those of Indian varieties, and he was not able to suggest any of them as being more suitable than others for further cultivation in Iraq. He pointed out, however, that until Iraq wheats become standardised and well-known on the market it may not be possible to obtain full prices for them, and that during the first years of importation the appearance of the grain will be the main factor in determining its price. For this reason it is of

great importance that shipments of Iraq wheats should be free from impurities such as dirt, stones, straw, and extraneous seeds. Mr. Kirkland placed the wheats in the following order of value, based on the character of the flour in dough and the nature of loaf produced, and assuming the flour to be used alone: 115, 187, 153, 204, 222, 158, 113, 192, 9, 31, 6, 36, 178, 243, 59, 39, 24.

General Conclusions

It will be seen that the flours from these wheats vary somewhat in their behaviour in bread-making, and on the whole are comparable to the flours from Indian wheats which show similar variations. In the United Kingdom these wheats would be used for mixing with more valuable Manitoba or Australian wheats. The most desirable feature in a flour is stability, and a stable flour would be in demand although of low gluten content. All the present samples would be suitable for mixing purposes in the United Kingdom, but as it is probable that the characters of the wheats will change to some extent during their continued cultivation in Iraq (i.e. the wheats obtained from different countries may eventually develop characteristic features due to Iraq conditions) it was pointed out that it would be advisable to continue cultivation trials with all the seventeen wheats for a number of years in order to determine the particular varieties which attain the best quality after acclimatisation.

APPENDIX

MEMORANDUM ACCOMPANYING MR. KIRKLAND'S REPORT

Explanation and Significance of Technical Terms

Size of Loaf.—A *strong* flour, if not sufficiently fermented, will produce only a small loaf; the loaf should be large if the dough has been fermented enough.

A *soft* flour produces a small loaf in all normal circumstances; by much mixing such a flour may be toughened in dough, and the resulting loaf made considerably larger, but none of the loaves referred to in the present report were so treated.

"*Strong*" *flour.*—The word "strong" is applied to flour when its gluten is tough. To produce a large loaf requires prolonged fermentation, or the addition to the dough of some softening agent.

"*Soft*" *flour.*—The word "soft" is applied to flour if in dough it is sticky and prone to flatten out; or if it makes a small close-texture loaf and may only be fermented on a "short" process. Flours with the first sort of softness are further described as "runny"; those with the latter kind of softness are described as "stodgy," or "putty-like." Some Indian wheat flours show the first characteristic; some, indeed most, English flours, white wheat Americans, and others, show the second.

Ripening of dough.—The size of a loaf depends almost wholly on the "ripeness" of the dough. The term is used as descriptive of the extent of the physical and chemical changes which have taken place in the gluten of the flour while the dough has been fermenting and while it has been under the influence of the enzymes of yeast and of other agencies operating in fermenting dough. Until the gluten of strong flour is "ripened," it remains very tough, and the bread made from it small in volume and tasteless. The same effects are apparent in dough and bread from soft flour but much less pronounced. If dough has been over-ripened, the resulting bread may again be small, and its crumb very friable. This condition is very easily produced with soft flours of the "stodgy" sort; not so readily with "runny" sort, as in some cases these improve if well fermented.

Short Process doughs (Straight).—A short process dough is one that is not allowed to ferment in bulk for more than 2 to 5 hours; and, as such doughs are generally mixed all at one operation—flour, yeast, salt and water together—they are also described as "straight" doughs. Flours with low gluten content—from 8 per cent. to 10 per cent.—are only suitable for short processes; those with a higher proportion of gluten—11 per cent. to 14 per cent.—do better with a longer process—8 to 12 hours in bulk.

Long Process (Straight and Sponge).—The longer process dough may also be made "straight," or it may be made at two operations, the first called the "sponge."

Stable Flours.—This is a term implying that the dough is not "runny," but readily keeps the shape into which it is moulded; while the resulting bread will have a shapely plump appearance. Stable flours generally require to be well fermented, to produce best results.

Bakers' ideals.—Bakers in Great Britain, particularly in the large towns, now nearly all work on short process straight doughs. For their purposes, they cannot easily use very strong tough flours, unless these are diluted with softer sorts. British millers prepare their flours to suit the bakers' needs, by selecting and mixing the wheats before grinding. This arrangement the bakers prefer, rather than buying flours from hard wheats, and flours from soft, then mixing them at the bakeries. It is the generally accepted ideal, that a flour, suitable for bread-making on a short process, should not contain beyond 10·5 to 11 per cent. of crude dry gluten. The character of that gluten is a matter of much importance. It should be stable, without being too stodgy or extremely tough, and, above all, it should not show a tendency to be "sticky" and "runny" in dough.

COFFEE FROM SIERRA LEONE

A SAMPLE of coffee beans and one of coffee in cherry have recently been examined at the Imperial Institute. The samples were forwarded to the Imperial Institute by the Commissioner of Lands and Forests, and were stated to be the product of *Coffea stenophylla* grown at the village of Leicester, and to represent the common variety of coffee cultivated in the mountain district of the Colony. It was desired to ascertain their quality and commercial value in comparison with commercial grades, and the prospects of establishing a market for coffee of this type in London.

The coffees were are follows:

"*I. Coffea stenophylla* (clean bean)."—These were small ungraded beans, in clean condition and of good appearance. A few pea-berries were present, and the sample contained small amounts of broken beans and pieces of husk. The beans, which were cream-coloured and

opaque, were covered with a tightly adhering, brown seed-coat. The average weight of a bean was 0·10 gram.

"*II. Coffea stenophylla* (in cherry)."—This sample consisted of fruits in good condition varying in colour from dark reddish-brown to black. The beans contained in the fruits were similar in shape and size to those of sample No. 1; they were covered with a tightly adhering, green to brown seed-coat and were cream-coloured and opaque.

The fruits consisted of husk 48 per cent., and bean 52 per cent.

The average weight of the fruits was 0·36 gram and that of the beans 0·11 gram.

The beans of Sample No. 1 were analysed with the following results:

	Per cent.
Moisture	8·2
Caffeine	1·3
Crude proteins	8·5
Fat	10·1
Carbohydrates, etc. (by difference)	50·6
Crude fibre	17·8
Ash	3·5

These results are generally similar to those recorded for Arabian coffee.

Importers consulted by the Imperial Institute considered the husked beans represented by Sample No. 1 to be worth about 68*s.* per cwt. in bond in London in June, 1923, when the following prices per cwt. were ruling for the principal commercial grades:

Mocha	85*s.*–120*s.*
East Indian bold to good	98*s.*–121*s.*
East African	60*s.*–126*s.*
Java (plantation)	80*s.*–125*s.*
Java (Liberian)	68*s.*– 75*s.*
Robusta	62*s.*– 68*s.*

The firm expressed the opinion that there should be a ready sale for consignments of coffee of similar quality to the present sample for consumption in the United Kingdom and mentioned that the coffee would also be saleable in Holland, Belgium and France, though they

doubted whether in these countries it would realise prices as high as in London. The importers further pointed out that in London the product would have the benefit of the preferential duty applicable to coffee produced in British Possessions. They stated that after roasting the beans they noticed a slight lack of "cleanness" in the taste, and suggested that care should be taken in curing the coffee in order to avoid this defect.

From the above valuation it is evident that the present product would rank as a coffee of somewhat low grade and could not compete with the superior commercial varieties. Consignments should, however, be readily saleable, and it was indicated that if prices such as that quoted for the present sample are likely to be remunerative the cultivation of the coffee in Sierra Leone might well be encouraged.

AGATHIS RESIN OF THE SOLOMON ISLANDS

In connection with the article in this Bulletin (page 333) dealing with the Solomon Islands and their resources, it may be of interest to place on record the results of examination of a resin received from that Protectorate some years ago. The tree yielding the material was identified at the Royal Botanic Gardens, Kew, as *Agathis macrophylla*, Lindl., a species allied to the kauri pine of New Zealand. In the letter from the Resident Commissioner, which accompanied the sample, it was stated that the resin occurs in large quantities, and that lumps of apparently fossil resin exceeding a cubic foot in size had been observed.

The resin was yellow and opaque, with a quantity of adherent and included bark and other vegetable débris. The material, which possessed a characteristic terebinthous odour, was mostly quite hard, but small portions in the interior of the larger masses were soft.

The crude product was scraped to remove the adhering bark, etc., furnishing 84 per cent. of fairly clean resin, which had a melting point of 110° C. and yielded 3·1 per cent. of volatile oil. The scraped resin, on being "melted" until it was completely soluble in turpentine oil, lost 20

per cent. by weight. The "melted" resin thus obtained, when dissolved in twice its weight of turpentine oil, gave a varnish which on exposure to air in thin layers dried to a hard and brilliant surface.

A spirit varnish, made by dissolving the resin in twice its weight of alcohol without previous "melting," gave a hard, brilliant surface on drying.

The volatile oil yielded by the resin to the extent of 3·1 per cent. was a pale yellow, mobile liquid, with a terebinthous odour. It had a refractive index at 24° C. of 1·475 as compared with 1·336 for water. The amount of oil available was insufficient for more detailed examination. Manila copal yields quantities of volatile oil varying from traces up to 12 per cent.

The residual resin left after removal of the volatile oil was of a buff colour and brittle, and still possessed a slight terebinthous odour. It was chemically examined with the following results:

		Present sample.	Figures recorded by Coffignier for soft Manila copal *
Moisture	*per cent.*	2·2	—
Ash	,,	0·05	—
Acid number		153·0	145·2
Saponification number		185·0	185·1
Melting point		127° C.	120° C.

* *Journal of the Society of Chemical Industry* (1908, **27**, 456).

The solubility of this residual resin in the following solvents was tested with the results indicated:

Alcohol	Completely soluble.
Ether	
Alcohol and ether	
Chloroform	Partly soluble.
Benzene	,, ,,
Benzene and alcohol	Completely soluble.
Turpentine oil	Partly soluble.
Turpentine and benzene	,, ,,
Turpentine and alcohol	Completely soluble.

These solubilities are similar to those of soft Manila copal.

The crude resin as received was submitted to a firm of varnish manufacturers, who pointed out that the quantity of foreign matter present would render the

cleaning of the resin an expensive process. They considered, however, that the resin might be used as a substitute for "spirit Manila copal" in the manufacture of spirit varnishes as this would not involve the previous cleaning of the material.

This resin from the Solomon Islands is of considerable commercial and scientific interest. As the foregoing results show, it closely resembles "soft Manila copal," a resin said to be derived from *Agathis alba* occurring in the Philippines and also in various islands of the East Indian Archipelago.

The principal difficulty in the way of exploiting the resin commercially is the large amount of bark, etc., that it contains, and it was pointed out to the authorities that it is very desirable that attempts should be made in the Solomon Islands to ascertain whether clean resin can be prepared from the crude material. For this purpose a system of cleaning and grading, similar to that used for Manila copal, was recommended, and full particulars of the methods employed were supplied in the report.

POTTERY CLAYS FROM UGANDA

Two samples of clays from Entebbe were forwarded recently to the Imperial Institute by the Government Geologist, Uganda, in order to ascertain their suitability for the manufacture of pottery, tiles, etc.

The clays were as follows:

"*Blue Clay.*"—This consisted of a compact clay in blue, white and pinkish-white layers; the blue portion, the colour of which was apparently due to the presence of graphitic material, predominating. Patches of yellow ochreous material were also present.

"*White Clay.*"—This was a soft whitish clay in the form of small lumps, some of which showed yellow stains; it contained a quantity of siliceous and micaceous material, together with small pieces of ochreous matter.

Results of Pottery Trials

"*Blue Clay.*"—This clay, after being coarsely ground and mixed with water, formed a very plastic mass, but a considerable quantity of hard clay was present. This hard material was, however, easily removable by washing, and in order to prepare from the clay a homogeneous mixture suitable for use in the production of fine pottery, it was considered preferable to remove the hard clay by this process instead of submitting the material to the extremely fine grinding which would otherwise be necessary.

On washing the original clay about 27 per cent. of hard material was separated. An attempt to use this hard clay for the production of tiles was unsuccessful, the product obtained after firing at 1,100° C. for 6 hours being weak.

The washed clay was submitted to chemical analysis with the following results :

		Per cent.
Silica	SiO_2	42·84
Alumina	Al_2O_3	37·22
Ferric oxide	Fe_2O_3	1·87
Titanium dioxide	TiO_2	2·21
Lime	CaO	0·16
Magnesia	MgO	0·20
Potash	K_2O	0·10
Soda	Na_2O	0·18
Loss on ignition	.	15·06

These figures show that the washed clay generally resembles ordinary ball clay in composition, but the percentage of alkali is somewhat low. It is also similar to ball clay in being very plastic when mixed with water.

Ball clay forms the basis of most ordinary pottery, but it is seldom used by itself, being usually employed in admixture with kaolin, flint and felspar or Cornish stone. In order, however, to test the behaviour of the washed blue clay on firing, a vessel made from it without any admixture was fired to a temperature of 1,140° C. A biscuit of a fairly good white colour was thus produced, but cracking had occurred, probably on account of the high shrinkage on drying and firing which amounted to a total of 13 per cent.

A tile made from a mixture of 60 parts of the washed

clay with 40 parts of fine sand was too weak to be of practical use, and warped badly on firing.

It is thus evident that the washed blue clay would be unsuitable for use alone, or in admixture with sand only, in the manufacture of pottery or tiles.

"*White Clay.*"—On washing this material, 15·5 per cent. of non-clayey residue was separated. The washed clay was then analysed with the following results :

		Per cent.
Silica	SiO_2	50·34
Alumina	Al_2O_3	33·74
Ferric oxide	Fe_2O_3	1·25
Titanium dioxide	TiO_2	1·31
Lime	CaO	0·16
Magnesia	MgO	0·28
Potash	K_2O	0·30
Soda	Na_2O	0·24
Loss on ignition		11·88

This analysis shows that the washed clay is more siliceous than ordinary kaolin, which, however, it resembles in texture and in its behaviour when mixed with water. The high percentage of silica is probably due to the presence of particles of fine sand which are carried over in the washing process and are not eliminated under ordinary conditions of large-scale washing.

Like ball clay, kaolin is seldom used alone as a pottery material. In order, however, to test the burning properties of the washed white clay, a vessel made from it was fired to a temperature of 1,140° C. A fairly good white biscuit was thus produced, with a total shrinkage on drying and firing of about 8 per cent., but its strength was not good. The washed white clay alone would therefore not be suitable for the manufacture of strong pottery at ordinary temperatures of firing.

Mixtures of " Blue " and " White " Clay.—Though neither the " blue " nor the " white " washed clays proved to be suitable for use alone in the manufacture of pottery, it was thought that a mixture of the two might give a more satisfactory result. A vessel was therefore made from a mixture of equal parts of the washed clays and was fired to the same temperature as before. A strong white

biscuit was thus produced. The total shrinkage was about 10·5 per cent., but this figure is somewhat high, and it is probable that large vessels, or vessels not of uniform thickness, made from the mixture used, would crack on firing. Evidence on this point was afforded by the fact that a small but rather thick-walled vessel made from this mixture at the Imperial Institute behaved in this manner, although thinner vessels showed no signs of cracking.

Manufacture of Earthenware

The most satisfactory means of utilising the present clays would be in the production of earthenware, for which purpose ball clay, kaolin, flint, and felspar or Cornish stone are generally required. It is probable that the "blue" and "white" washed clays would serve adequately for the first two constituents and local supplies of "flint" (in the form of quartz or silica sand) and felspar might be obtainable. These materials would, however, have to be ground extremely fine before use.

Fired earthenware bodies of approximately identical composition could be made from either the white or the blue clay in admixture with suitable quantities of flint and felspar, but the best mixture to employ would be one which contained both the blue and white clays (i.e. in effect, both ball clay and kaolin as in ordinary practice). A desirable composition for the fired earthenware body to be made from the clays would be approximately:

		Per cent.
Silica	SiO_2	75·3
Alumina	Al_2O_3	20·5
Bases	CaO, MgO, K_2O, Na_2O	4·2

In order to obtain earthenware of this composition, mixtures of flint and felspar with (*a*) blue clay, (*b*) white clay, and (*c*) equal parts of blue and white clays, were made in the following proportions:

	(*a*) Blue Clay.	(*b*) White Clay.	(*c*) Equal parts of Blue and White Clay.
	Per cent.	*Per cent.*	*Per cent.*
Clay	38	42	40
Flint	46	42	44
Felspar	16	16	16

These mixtures would theoretically give fired bodies of approximately the following composition:

		(a) Blue Clay.	(b) White Clay.	(c) Equal parts of Blue and White Clay.
		Per cent	Per cent.	Per cent.
Silica	SiO_2 . .	74·1	74·7	74·3
Alumina	Al_2O_3 . .	19·6	19·4	19·4
Bases	CaO, MgO, K_2O, Na_2O	4·2	4·2	4·3

Vessels made from these mixtures were fired at a temperature of 1,130° C. for 6 hours, and gave strong, porous, almost white biscuit, which could easily be covered with a suitable glaze to render the ware impervious to water. The colour of the biscuit could be improved, if desired, by the addition of a little finely-ground oxide of cobalt (0·02 to 0·08 per cent.) to the body mixture.

The total shrinkages of the three earthenware biscuits produced were respectively (*a*) 8·3 per cent., (*b*) 6·6 per cent., (*c*) 5·8 per cent. Thus, though there was little difference in appearance between the fired wares, the earthenware (*c*) made from the mixture of blue and white clays showed considerably less shrinkage than that made with the blue clay, and its use is, therefore, to be preferred. The earthenware (*b*) made from the white clay showed a slightly higher shrinkage than that made from the blue and white together; the mixture in this case was difficult to work and the unfired ware was weak.

Another earthenware mixture was also made, containing a larger percentage of clay than those previously tried, the proportions of the constituents being as follows:

	Per cent
Blue clay	40
White clay	20
Flint	30
Felspar	10

The calculated composition of the fired body made from this mixture would be:

		Per cent.
Silica	SiO_2	67·5
Aluminia	Al_2O_3	26·7
Bases	CaO, MgO, K_2O, Na_2O . .	3·2

A vessel made from this mixture and fired at 1,130° C. gave a strong biscuit with a total shrinkage of 6·0 per cent.

Tiles suitable for decorative purposes were made from the earthenware mixture (*c*) and fired at the same temperature. The tiles produced were strong and could be readily glazed.

Tiles were also made from a similar earthenware mixture in which the ground flint was replaced by fine silica sand. These tiles, though strong, had a tendency to warp on firing, and their appearance was not so good as that of the tiles described above.

Impermeable stoneware can be made from the materials generally used for earthenware, by varying the proportions and by increasing the temperature of firing. A trial was therefore made to determine whether a mixture of the blue and white clays could be used in this manner, the following proportions being employed:

	Per cent.
Blue clay	25·5
White clay	25·5
Flint	39·0
Felspar	10·0

A vessel made from this mixture and covered with a felspathic stoneware glaze gave strong impermeable ware when fired at a temperature of 1,320° C.

Stoneware could also be made by using the blue and white clays separately, but the disadvantages mentioned in connection with the earthenware trials would also apply in this case.

The results of the foregoing tests show that a mixture of the washed blue and white clays is quite suitable for use in the manufacture of earthenware or stoneware, provided that proper conditions of firing are maintained. In this or any other case, however, in which the blue clay is employed, it should be noted that as it contains a quantity of graphitic matter it is essential that an oxidising atmosphere should be employed in firing, in order to ensure the complete combustion of this substance.

Manufacture of Roofing Tiles

Although neither of the clays resembled those from which roofing tiles are generally made, trials were made with the blue clay in order to determine whether strong tiles

suitable for roofing could be made from it. For this purpose the unwashed raw clay was ground to pass a sieve of 20 meshes to the linear inch, and was mixed with water. Tiles were then made both from the raw clay and from the raw clay in admixture with 20 per cent. of "grog" (raw clay fired to 1,100° C.) and also with 30 per cent. of the latter (the grog being ground to the same fineness as the clay) and were fired to 1,130° C. for 6 hours.

The tiles made in this trial from the clay alone proved to be weak, and were intersected by large numbers of fine cracks, possibly caused by a difference in shrinkage between the bulk of the material and the hard clay constituent. Fairly strong tiles, with a crossbreaking stress of about 600 lb. per sq. inch (compared with about 2,000 lb. per sq. inch for an ordinary commercial roofing tile) were made from the mixture of clay with 30 per cent. of grog, but in some cases considerable warping took place. The colour of the fired ware (white, tinged with pink) might, however, be unsuitable for tiles intended for roofing purposes, and if so it would be necessary either to colour the body mixture by some suitable medium, or to face the tiles before firing with a coloured slip or after firing with a waterproof colour wash. An attempt to colour the tiles by the addition, before firing, of 30 per cent. of Uganda iron ore was unsuccessful, no appreciable improvement being produced.

It seems probable that ferruginous clays could be found locally which would be more suitable for the manufacture of roofing tiles than either of the present clays. If such were the case, the comparative weakness of the roofing tiles made from the blue clay, the difficulty of firing without serious warpage, and the necessity for artificial colouring, would render it unprofitable to use the blue clay in this manner, particularly in view of the fact that after washing it is well adapted for finer work. No tests were carried out in this direction with the white clay, which, being essentially a kaolin, would not be suitable for the manufacture of roofing tiles.

The following specimens, illustrating the experiments made with the blue and white clays at the Imperial

Institute, have been supplied to the Uganda Section of the British Empire Exhibition :

Glazed earthenware. Test piece made from a mixture of the blue and white clays with flint and felspar.

Unglazed earthenware tile. Test piece made from a mixture of the blue and white clays with flint and felspar.

Glazed earthenware tile. Test piece made from a mixture of the blue and white clays with flint and felspar.

Stoneware. Test pieces made respectively from (*a*) a mixture of the white clay with flint and felspar, and (*b*) a mixture of the blue and white clays with flint and felspar. Both specimens covered with a felspathic glaze.

ARTICLES

THE BANANA AND ITS CULTIVATION, WITH SPECIAL REFERENCE TO THE BRITISH EMPIRE

Among the many fruits which are native to or are cultivated in the tropics, the banana takes a leading place both as regards its local uses as a native foodstuff and its importance in overseas trade. Its high standing as an article of export is due to several factors ; the plant is easily grown and gives an early return ; it is prolific, and a crop can usually be assured ; the fruit travels well in cold storage and arrives in a presentable condition in countries far distant from its place of origin ; its easily removable skin protects the edible portion from contamination during handling ; it can be retailed at a low price and, besides being eaten as a raw fruit, it can be employed as a food in many other forms.

The trade in bananas is a highly organised one and much capital has been sunk in developing it to its present large dimensions. The first importation of bananas into the United States took place in the late sixties, but it was not until the formation of the United Fruit Company in 1899 that the industry became important. Small importations into the United Kingdom were made from Madeira in 1878 and from the Canary Islands about 1882, but shipments in special steamers were not made until 1901. At first

bananas were a luxury and, as they were expensive, the demand for them was small and confined to a few classes. The key to the success which has attended the banana industry was found to be small profits on a large scale, and these were obtained by keeping the price within the means of the poorest, thereby creating a large aggregate demand from numerous consumers.

Some idea of the present dimensions of the trade may be gathered from the following tables which give the imports from the principal producing countries into the United States of America and the United Kingdom, which are the principal markets for bananas in northern temperate regions.

Imports of Bananas into the United States

Countries of Origin.	1913*	1919.	1920	1921.	1922.
	bunches.	*bunches.*	*bunches*	*bunches.*	*bunches.*
Costa Rica .	6,973,684	4,060,500	5,402,235	3,998,930	3,704,727
Guatemala .	2,359,250	2,445,020	3,634,367	4,385,000	4,498,800
Honduras . .	7,983,591	11,359,578	11,488,418	13,173,225	14,584,674
Nicaragua . .	1,681,944	847,906	1,338,757	1,931,248	2,603,491
Panama . .	4,438,300	4,899,027	4,558,947	3,976,602	3,665,378
Mexico . .	1,541,504	175,411	728,405	1,428,687	739,186
Cuba . .	2,213,733	1,515,832	1,697,020	1,774,161	1,808,872
Colombia . .	2,684,749	4,094,940	2,679,154	3,515,236	2,205,538
British Honduras	651,064	681,430	583,462	457,026	460,825
British West Indies (chiefly Jamaica) .	11,164,894	6,912,779	7,143,128	8,687,005	10,689,186
Other Countries .	664,396	672	65,669	38,643	134,215
Total quantity, bunches . .	42,357,109	36,993,095	39,319,562	43,365,763	45,093,892
Total value $	14,484,258	15,934,590	19,087,927	19,385,174	19,145,911

* *For fiscal year ending June* 30, 1913.

Imports of Bananas into the United Kingdom

Countries of Origin.	1913	1919.	1920.	1921.	1922.
	bunches	*bunches*	*bunches*	*bunches.*	*bunches.*
Canary Islands . .	2,138,080	1,871,590	2,322,842	2,646,072	2,645,444
Republic of Honduras .	—	—	—	53,680	1,185,492
Costa Rica . .	2,614,186	—	168,939	1,439,938	1,228,059
Colombia . . .	2,255,504	255,692	3,374,634	3,925,788	4,163,695
Other Foreign Countries	32,451	533	762	51,469	3,507
Total Foreign Countries	7,040,221	2,127,815	5,867,177	8,116,947	9,226,197
British West Indies (chiefly Jamaica) .	499,763	2,768,844	2,190,448	1,384,618	1,804,963
Total quality, bunches.	7,539,984	4,896,659	8,057,625	9,501,565	11,031,160
Total value . £	2,172,688	3,908,393	6,468,719	6,553,016	5,315,109

It will be seen from the foregoing tables that the principal northern markets are supplied chiefly by Central American countries, Jamaica and the Canary Islands. The United States of America is the world's largest market, over 45 million bunches being imported in the year 1922, chiefly from Central America and the West Indies, more than half the total import being supplied by Honduras and Jamaica. The greater part of the United Kingdom supply is obtained from foreign countries, chiefly from Colombia and the Canary Islands, the only country in the Empire supplying appreciable quantities being Jamaica. The Australasian supply, outside the Australian production, is chiefly derived from Fiji and Netherlands East Indies (Java). The export from Fiji fluctuates considerably, but in 1920 was 759,830 bunches valued at £95,315, of which quantity New Zealand imported 460,339 bunches and Australia the remainder.

In view of the fact that the banana can be grown in most tropical lands where labour is available, and that several tropical countries in the Empire are closer to home markets than the Central American countries principally concerned with this trade, it would seem advisable to consider whether a greater share in the banana industry could not be undertaken within the Empire, more particularly in parts of West Africa which are within a comparatively short distance of the home markets.

The Banana Plant

The plants which produce the banana fruits of commerce belong to the genus *Musa* of which several species are known. Only two species are, however, concerned in the banana fruit industry; these are *Musa sapientum* and *Musa Cavendishii.* To the former belongs the variety "Gros Michel," which is the principal kind grown in Central America and Jamaica.

This variety is a rapidly growing herbaceous perennial, attaining a height which varies according to the richness of the soil in which it is grown but may be as much as 40 ft., although the average in Jamaica is from 18 to 25 ft., and in Cuba 12 to 18 ft.

It produces very large, rather straggling bunches of pointed fruits which are somewhat coarse as compared with the Canary Islands banana. They can, however, withstand a considerable amount of handling without damage, and as they can be exported without crates they are the most popular for market purposes. There is a coloured form of this variety known as the " red " or " claret " banana for which there is a comparatively small demand.

Musa Cavendishii, or *M. sinensis*, commonly known as the Chinese, Cavendish, Dwarf or Canary Islands banana, is native to Southern China whence it has been introduced to the Canary Islands and to many countries in the East and elsewhere. The plant is much smaller in all respects than the " Gros Michel," attaining a height of only 10 to 12 ft., and this, together with its robust habit, renders it more capable of withstanding violent winds and hurricanes; it is, in consequence, adapted to cultivation in countries where these are likely to occur. Its fruit is much smaller not only as regards size of bunch but also in respect of the individual fruits, which are short and not so pointed as the " Gros Michel " ; when mature they are deep golden-yellow, the flesh is " melting," aromatic, and of finer flavour than those of " Gros Michel," but the skin being more delicate is liable to injury during transport and for this reason the bunches are always exported in crates.

The apparent stem of the banana plant really consists of the basal portions of the leaf-stalks which overlap so as to form a protective sheath to the young leaves which develop within, and also serve in the place of a woody stem to support them. Distinct leaf-stalks are formed above the sheathing bases which constitute the stem, and these support the large curving leaf-blades, or fronds, which are often of great size, attaining a length of up to 8 to 12 ft. and a breadth of up to 2 ft. The real stem of the plant is a thickened underground root-stock, usually called the " bulb," from which the leaves and flower-spike spring and which gives rise to buds or " eyes " from which new plants are formed. As many buds or " eyes " arise from each root-stock a small colony of plants would originate from a single base if they were all allowed to develop, and each in time would form a root-stock of its own.

PLATE VI.—BANANA PLANT IN FRUIT IN JAMAICA

Showing "sword sucker" close to stem to the left and "follower" to right

Photo by E. Wells Elliott, Kingston, Jamaica

Reproduced by the courtesy of the Jamaica Section, British Empire Exhibition

PLATE VII.—MATURE BANANA PLANTATION IN JAMAICA

View along a roadway between the blocks of bananas

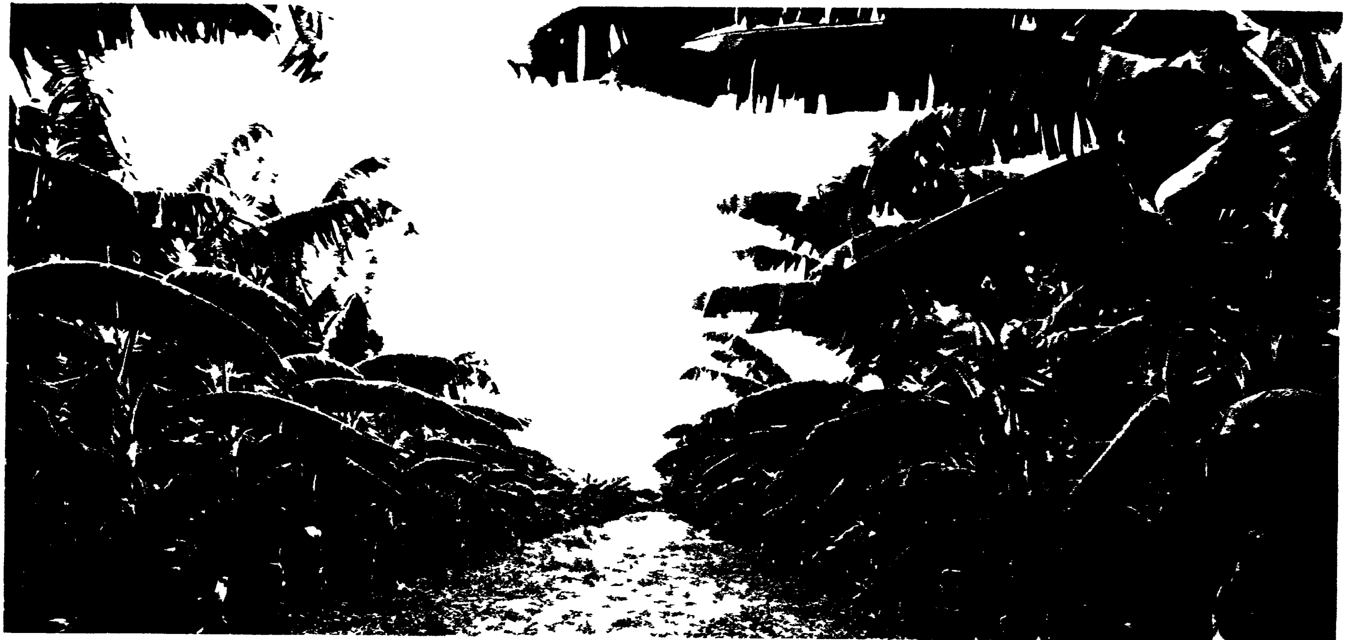


Photo by E. Wells Elliott, Kingston, Jamaica · *Reproduced by the courtesy of the Jamaica Section, British Empire Exhibition*

When mature, the plant produces an inflorescence (flowering stalk) from the root-stock and this emerges from the centre of the tuft of leaves and ultimately becomes the bunch of bananas. The inflorescence is a terminal spike with flowers arranged spirally in clusters, each cluster protected by a coloured bract. The flowers are of different kinds; those at the base are pistillate or female flowers and eventually develop into banana fruits; those at the upper portion are staminate, or male flowers, which fall off, leaving scars on the bare stalks; whilst a few intermediate ones are either hermaphrodite or neuter flowers, the former developing only small and useless fruits. The flower-spike is at first erect, but the weight of the flower-head causes it to bend over and eventually to point vertically downwards. The fruits which succeed the flowers are arranged spirally on the stalk in groups or "hands," each "hand" consisting of from 10 to 25 individual fruits or "fingers." The plant bears but a single bunch of fruit in its life cycle and this in the case of "Gros Michel" may be from 50 to 75 lb. in weight, composed of from 6 to 9 "hands," and is occasionally much larger. The Canary banana bunches usually carry from 125 to 250 fruits and weigh from about 25 to 65 lb. or more.

Climate and Soil Requirements

To produce the fruit to the best advantage a tropical climate, a rich alluvial soil, preferably river-bottom lands, and a considerable rainfall or means of artificial irrigation, are essential. Ideal conditions for banana cultivation are found in Central America where the mountain range which runs along the coast-line on the Pacific side gives off subsidiary ranges running eastward, leaving wide slopes, river valleys, and rich lowlands on the Caribbean Sea. In this locality, a few miles inland from the sea, at an elevation of not more than 250 ft., the rainfall is from 80 to 200 in. annually, and the hot days, succeeded by humid nights, provide the requisite conditions for the maximum growth of the banana. The plantations in this area are usually started in virgin land, for which purpose the forest growth is cleared and burnt off and the banana "bulbs"

are planted at intervals in the cleared ground; or the "bulbs" are planted first and the trees felled afterwards and allowed to decay on the ground. In Jamaica it has been found that bananas succeed on a wide range of soils, provided that drainage is satisfactory and tillage with modern implements is adopted. In the Canary Islands the soil is for the most part volcanic and is deficient in most plant constituents except potash. Although rich alluvial soils are selected for preference when these are available, the physical and mechanical conditions of the soil for bananas appears to be of more importance than its chemical composition; even stiff clays, if well drained and cultivated, have been found to yield good results, whilst soils deficient in humus or decayed vegetable matter may be rendered suitable in this respect by green manuring and dressings of vegetable refuse. The first and most important thing to do in forming a banana plantation is to prepare the land thoroughly by deep ploughing and sub-soiling or preferably by trenching. Good drainage is absolutely essential for successful banana cultivation, drains being necessary on hillside slopes as well as in flat areas, where the soil is not naturally sandy or loamy. On hillsides the drains should run across the slope with only sufficient fall to carry off the water; they should be at least 2 ft. deep, and should be made to discharge into horizontal catchments for collecting the débris and washed-out soil, which can be used as top-dressing when the catchments are cleared. In areas where the rainfall is insufficient artificial irrigation must be resorted to, and many excellent crops such as those in Colombia and in the Canary Islands are largely grown on irrigated land. The irrigation channels should be made close to the plants when they are young, but should later be made in the centre of the rows.

Propagation and Planting

The banana does not usually produce seed, and hence a vegetative method of propagation is employed when new plantations are formed. For this purpose the "suckers" or young plants which form at the base of the parent plant are used. These have narrow sword-shaped leaves when

young and are then known as "sword-suckers." When about 8 months old they assume adult leaves and are then at the best stage for planting. They are cut down to within about 6 inches of the "bulb," the old roots are removed, and the heart eye is destroyed, as well as any others that may be present with the exception of one, the largest and fullest, which is retained to develop into the future plant. The "suckers" should be carefully lifted so as not to harm the bud, which is particularly liable to injury at the point where it is attached to the "bulb" or root-stock. The prepared suckers may be planted at once or they may be kept for a few weeks if stacked or protected from the sun by a covering of banana leaves or trash. If "sword-suckers" are used the leaves should be trimmed off and the side buds removed, the heart bud being retained in this case to develop into the future fruiting plant. In selecting suckers for planting, care should be taken to see that they are derived from clean stock, otherwise fungus or insect pests are liable to be introduced.

In Jamaica the "Gros Michel" banana suckers are planted in pits dug at least 1 ft. 6 in. deep, at a distance of not less than 12 ft. apart, but as much as 18 to 24 ft. between the plants is allowed in Central American countries where the soil is richer and growth more luxuriant. The Canary banana, being a smaller plant, is spaced about 10 ft. in planting, the distance depending upon the nature of the soil. The bulbs should be planted at a proper depth in the soil, the top of the "bulb" being not more than 6 in. or less than 3 in. below the surface of the soil when the pits are filled in.

The "hollow arch" portion of the sucker should be turned in the direction of the prevailing winds, especially in exposed districts where wind belts are not planted, as the leaves are then directed towards the wind and this gives the plant greater stability when fruiting. The earth removed from the hole made for planting should not be used for filling in; the finer surface soil should be used for this purpose, but if found necessary to employ the original soil it should be left exposed to the action of sun and air for some time to sweeten before being used. The usual time required for the original plant suckers to fruit is 10 months

after planting, or longer in some situations; and from 2½ to 4 months are required to mature the fruit. It follows that at least 12 months must be allowed before a crop can be obtained. The best time for planting in order to secure crops early in the year is therefore in the autumn months or early spring.

Cultivation

The cultivation after planting varies according to the locality and rainfall. In dry areas it is essential to keep a surface mulch of dry soil by harrowing or hoeing in order that the evaporation of the soil moisture may be prevented. In certain districts a thick mulch of dry vegetable matter, such as grass or leaves, is employed for this purpose. In wet districts the principal operations are concerned with keeping down weeds by hand-weeding or forking between the rows, or by cutlassing if the growth is very dense. A green manure crop is sometimes grown and this is not only useful in keeping down weeds, but it provides a mulch and enriches the soil with the organic matter required by the banana crop, whilst at the same time it prevents soil wash. A leguminous crop should be used for this purpose, such as Jerusalem pea (*Phaseolus trinervis*), Bengal bean (*Mucuna utilis*) or cow peas (*Vigna Catjang*). The growth of the green manure crop should be cut down as soon as the plants begin to blossom and should be spread on the ground to rot, after which it may be forked into the soil. Ploughing or disc harrowing between the rows is also advisable at intervals up to the time of fruit development, as this not only helps to keep down weeds but tends to improve the soil conditions and renders more plant food available.

Pruning or Suckering

As previously mentioned, the banana plant throws out numerous suckers from the root-stock, and if all these were allowed to develop they would not only starve the parent plant but would crowd each other, and a poor crop of fruit would result. It is important, therefore, to thin out the suckers in such a way as to permit of the parent plant producing fruit of good size, and, at the same time, allow

sufficient young plants to develop to provide suckers for replanting the land after the parent plants have fruited and been cut down. The pruning, or removal of superfluous suckers, is therefore an important operation, which should be carried out at an early stage when the sucker is not more than one or two feet high. The unwanted suckers should be cut away by means of a cutlass, the cut being made away from the parent plant so as not to injure the latter. The suckers must be cut away right down to the white, hard part of the root-stock, as if only the tops are removed they will soon spring up again.

In selecting suckers to remain for furnishing the plantation, their position and probable time of fruiting should be taken into consideration. Those which start from eyes placed low down are to be preferred as they have a good roothold in the soil. Pointed suckers with narrow leaves are usually the most vigorous and these should be selected where possible. A sucker developing on the "stump," or portion of plant that remains after the fruit has been harvested and the top cut down, should never be retained for refurnishing the plantation, as this develops into what is known as "water-sucker," a vigorous-growing plant which yields only a small bunch of fruit. Two or three suckers ("peepers") should be left round the base of each parent plant. Usually one of these takes the lead and this fruits in from 10 to 14 months, the other one or two fruiting 4 to 5 months later. The selection should therefore be made according to locality and length of time required for development with a view to obtaining fruit at the time of highest prices, which in the United Kingdom is from March to June.

"Ratoons" or suckers that develop in subsequent years after the fruit has been harvested from the parent sucker are spoken of as first, second or third year ratoons according to age. These may take from 21 to 25 months to mature a crop, and should therefore be selected at a suitable time to ensure fruiting during the spring months of the year.

The suckers or "followers" that arise along the row should be retained rather than those that develop between the rows as this tends to retain the original alignment and

maintains space for the proper cultivation of the soil with horse or mechanical implements.

HARVESTING

As already stated (p. 309), in about 10 months or somewhat more from the time of planting the banana plant has "shot" or produced its flower stalk, and in a further 3 months the fruit is usually mature, the time varying with weather conditions. The harvesting of the fruit is done by cutting the trunk just below the bunch by means of a special knife attached to a pole. The weight of the bunch of fruit causes the top of the tree above the cut to bend over on one side, and in order to prevent it crashing and damaging the fruit, it is steadied by the pole until the bunch of fruit is within reach, when it is severed from the tree by means of a cutlass. In Central American countries a "gang" of three men usually work together to carry out these operations, but in Jamaica a "cutter" usually works alone.

After being cut the fruit is wrapped in the long dry leaves of the banana plant to prevent bruising and is conveyed as quickly as possible to a centre for classification and grading or direct to the wharf for shipping. The classes are based on the number of "hands" to each stem; in the case of the "Gros Michel" variety, these are known as "nines," "eights," "sevens" and "sixes"; and these are graded according to the fullness of the fruit, the grades being expressed as "thin" "three-quarter," "full three-quarter" and "full." Canary Island bananas are classed as "giants" with 250 or more fruits weighing about 65 lb.; "extras" with about 200 fruits, weighing 55 lb. or more; firsts with 160 fruits, weighing 45–50 lb.; and seconds with 125 fruits, weighing 25–40 lb.

In large, up-to-date plantations tram lines are laid throughout the plantations and these connect up with railways which in their turn convey the fruit to the steamer. Speed in transit from the plantation to the steamers is essential and many labour-saving mechanical appliances are employed to facilitate handling at the port and to avoid damaging the fruit. Inspection is necessary at each stage

of the proceedings in order that all over-mature or defective bunches may be detected and eliminated.

To determine the exact degree of maturity required, in order that the fruit may arrive at its destination in the best possible condition, considerable judgment is necessary, and it is only by experience that this can be acquired. The degree of development at which the bunches are harvested depends upon their intended destination ; for example, bananas from Central America intended for the United States may be more fully matured than those intended for the United Kingdom market, as the sea journey to the States is much shorter.

After-Cultivation

When harvesting is completed, the old stumps or " yams " should be removed by " stumping " with a mattock before they rot, the holes made being filled in with good soil. A special curved, spade-like implement, called in certain states of Central America a " baraton," is sometimes used for this operation. The stumping should be done as soon as the sword-suckers selected as followers have attained a height of not less than 5 ft.

In good soil, with careful attention to suckering so as to keep up a supply of suitable plants for fruiting, and with the use of chemical fertilisers and natural manures, the plantations will last for a number of years, some of the plantations at Santa Marta in Colombia, for instance, being over 40 years old ; but eventually the ratoon plants will show signs of exhaustion and yield smaller bunches ; they are also liable to form " bulbs " above ground, and when this happens they are likely to be blown over in strong winds. The original alignment of the plantation also becomes lost after a number of years, and this makes cultivation difficult. In Jamaica it is found to be profitable to replant after the third or fourth ratoon crop has been harvested, that is, not later than the fifth year after the original plantation was formed. The replanting may be done between the old rows in the existing field if these are sufficiently wide apart, the suckers in the old rows being afterwards removed ; or the whole field may be cleared before being replanted.

In the latter case advantage should be taken of the clearing to plough and lime the land, and to raise a leguminous crop which should be fed off by grazing cattle before the replanting takes place, thereby enriching the soil with humus.

In order that the labour of replanting should not be too heavy in any one year, it is advisable to plant a certain area each year and adopt a system of replanting under which each area would be renewed in rotation every sixth year.

Packing and Transport

As previously stated, the "Gros Michel" bananas are shipped naked, each class of fruit being separately stowed on board. The bunches are stood on end, in tiers, in bins or compartments constructed of wooden bars, which prevent them from rolling and becoming crushed, whilst the spaces between the bunches allow of free air circulation. The Canary or Chinese bananas are packed in crates for shipping as they are liable to injury by handling. The hexagonal wooden crates usually employed for this purpose are first lined with straw or banana trash, and the bunch of fruit is wrapped in cotton wool and covered with paper, the latter being held in position while the bunch is being placed in the crate by strings made of strips of the leaf-sheath. After the bunch is in the crate it is firmly fixed by pressing in trash all round it, and when this has been done the strings holding the paper wrapping are cut and withdrawn, and the slats forming the top of the crate are nailed on. The quality of the bunch contained in the crate is indicated by marks on the outside; a bunch weighing from 40 to 49 lb. is marked "X"; one weighing 50 to 59 lb. is marked "XX"; one weighing 60 to 69 lb. "XXX," and extra sizes are specially indicated.

Specially designed steamers are employed in the banana trade, and these are not only fitted with refrigerating machinery to maintain a low and even temperature, but are provided with ample means for ventilation in order that the carbon dioxide and heat which the bananas give off whilst in storage may be removed. Before the bunches of bananas are placed on board it is usual to

cool down the holds of the refrigerator ship for some 24 hours, and as soon as the ship is loaded the temperature is reduced to the required degree and is maintained as nearly as possible at this level during the voyage.

The unloading of a banana ship and the transference of the fruit to cold storage in banana warehouses to ripen is largely done by mechanical contrivances so as to avoid damage by handling and to shorten the time required. Specially constructed insulated railway trucks, that can be kept cool during hot weather and heated when it is cold, are employed for the distribution of the fruit to inland centres after being removed from the ship. At these centres the fruit is usually kept in cold storage until in a suitable condition for distribution to retailers.

Bananas need careful handling at all times, and will only travel safely when they are in an unripe condition. It is necessary therefore for the retailer to complete the ripening process, and for this purpose small special rooms are usually employed in which the fruit required for sale from day to day can be matured.

Fungus and Bacterial Diseases

Panama disease.—The most destructive of the several fungus diseases to which the "Gros Michel" banana is subject is that known as the "Panama disease" or "banana wilt." This disease has caused enormous losses in Cuba and in Central and South American countries, from Brazil to the United States border, except in the Santa Marta district of Colombia where the plants are grown under irrigation. It is also prevalent in the Philippines and in Jamaica and strict control measures have had to be enforced. The disease is attributed to a fungus, *Fusarium cubense*, which enters the plant at the root and gradually penetrates to the bulb, and later to the leaf stems. The presence of this fungus can be detected in the internal tissues of the "stem" and bulb by yellow, orange or red markings; and as its growth fills the vessels it stops the supply of water from the roots to the leaves. The diseased plants suddenly wilt, as if suffering from drought, and this is followed by rapid yellowing and subsequent browning

of the leaves, which eventually fall against the stem. Finally the whole column falls and rots. In view of the serious nature of the disease, control measures should be adopted immediately the symptoms are detected and the affected plant should be dug up at once and destroyed by burning. The plants in the immediate neighbourhood of those affected should also be destroyed as, although they may appear healthy, the probability is that their roots are attacked, and it is better in any case to sacrifice them than to risk a spread of the disease. The soil in which the diseased plant was growing should be limed and the cleared area (for a distance of a chain all round) should be fenced off so as to completely isolate it, and no person should be allowed to enter the enclosure, as the disease is capable of being spread by soil adhering to workers' boots. Every part of the diseased plant should be burnt on the spot and should not be removed to other parts of the plantation, and all tools employed in cutting up diseased plants should be sterilised by heating, and workers hands, feet and clothes should be disinfected. A recent Government order in Jamaica requires that all banana trash employed in wrapping or packing bananas shall be destroyed by burning and shall not be removed from the various collecting centres, as mulching with infected trash has been a factor which has contributed to the spread of the disease. The persistence of the disease in the soil has been proved in Jamaica to extend to a period of at least 10 years. Bananas cannot therefore be safely planted on land where the disease has once appeared.

The exact conditions predisposing plants to this disease are not known, but it is probable that in very wet climates where there is no definite dry season, bad drainage and resulting sourness of the soil may favour the disease. In preparing land for bananas it is therefore advisable to trench before planting, and to provide ample sub-soil drainage so as to eliminate risk of stagnant water being retained in the soil. The Chinese or Cavendish banana has not so far been affected by this disease, and several other local varieties in Jamaica are known to be immune. The question of producing an immune variety for commercial purposes is now being seriously considered.

A disease of the Panama type occurs in Java where it was first observed in 1915 in the neighbourhood of Buitenzorg. The affected plants show discoloration of the vascular tissues from the roots upwards and occasionally there is wilting of the leaves, but so far, the fungus has proved of little economic significance.

Blood disease.—In Dutch Celebes this disease has caused considerable damage to bananas. The leaves and also the fruits are affected, and internally the vascular tissue shows discoloration similar to that caused by Panama disease. The most obvious symptom is the presence of yellowish-brown stripes on one or more of the younger leaves commencing at the midrib and gradually extending to the leaf margin. This may last for some time until the fruit is almost completely developed, when suddenly the whole leaf crown turns yellow and breaks down. The skin of the fruit turns yellow whilst the interior becomes filled with a slimy red fluid ; the fruit finally drops and decays. This disease is attributed to a bacterium which gains access by the roots. Young plants become affected from the mother plant and the disease is also spread by infected soil. Insects and wind are also capable of spreading the disease by dispersing the bacteria to sensitive parts of the plant, such as the stigmas of the flowers. In the absence of any remedy for this disease, the destruction of affected plants by burning is recommended.

Bunchy top or Cabbage top.—This is a disease affecting the plant the cause of which is not definitely known. It is prevalent in certain districts of Queensland and New South Wales and has also occurred in Fiji. The characteristic feature of the disease is the tendency for the leaves to remain more or less erect and close together in a bunch instead of expanding normally ; hence the common name for the disease. Both the leaf-blades and stalks become very brittle and the cap protecting the young leaf frequently breaks off, allowing rain-water to enter the centre, and this sometimes causes decay, in which case there is an offensive odour. The surest indication of the disease are dark green lines that form on the under-sides of the leaf-stalks. The fruit bunch, if it develops at all, is small and puny and the fruits turn black at he tips. The roots of affected plants

are invariably unhealthy, the extremities are usually dead and sometimes the diseased portions extend to the bulb. Numerous eelworms are usually present, but it is not yet proved that these are the original cause of the trouble. It is probable that faulty soil conditions are a predisposing cause, due to bad drainage, or to the absence of some essential constituent. The control measures recommended are improved drainage, and manures containing potash and phosphates. The isolation of affected areas is now enforced in Queensland with a view to checking the spread of the disease, and a thorough investigation as to its cause is being undertaken by the Government.

Banana Heart Rot, or *Heart Leaf Rot*.—The cause of this disease, which occurs in some localities, is obscure but is probably due to a bacterium. In affected plants the terminal leaf which extends down the central "stem" decays and gives off an offensive odour. The control measures consist in cutting down the plant below the affected part and destroying it by burning. The suckers following a diseased plant are not usually attacked, but as a precautionary measure they should be sprayed with Bordeaux mixture.

Marasmius disease.—This disease, which is not usually serious, but which occasionally causes the death of plants, is produced by *Marasmius semiustus*. The mycelium of this fungus attacks the leaf-sheaths near the soil level. It penetrates the tissues of the stem of the plant and attacks the central flower-stalk. The fructifications of the fungus appear on the exterior of the stem as small toad-stools, the caps varying from ½ in. to 1 in. in diameter. The disease is favoured by moist conditions accompanied by cold weather, and usually attacks plants growing in dense grass or in badly drained, water-logged soil. It is also liable to result from the application of excessive quantities of nitrogenous manures at the base of the plant. These conditions favouring the disease can be remedied by cultural methods and by clean cultivation.

Black Spot.—This disease of the leaves is due to *Cercospora musarum*, a fungus which attacks plants in Jamaica, Fiji and elsewhere, but seldom causes serious damage. The attacks begin as tiny black spots on the main

veins of the leaf-blade. These spread and become roundish blotches with a yellow border, which later turn brown and unite with others, giving rise to a broad zone of dry tissue extending round the outer half of the leaf-blade. Spraying with Bordeaux mixture is recommended to keep the disease controlled.

Banana Freckle.—The banana fruit in Hawaii and the Philippines is subject to this disease, which is attributed to *Phoma musae*, a fungus known to occur on a variety of plants. The disease causes unequal ripening of the fruits and also gives them an unsightly spotted appearance which detracts from their value and renders them unfit for export purposes. The disease could probably be controlled by the use of Bordeaux mixture.

Finger-tip Rot.—This disease of the fruit of the Chinese banana is reported from Jamaica. It is due to a fungus which attacks the remains of the flower at the tip of the fruit and causes it to rot. The remedy suggested is trimming each finger of the bunch with a knife some time before the bunch is cut, as the flower is not shed naturally in Jamaica as it is in the Canary Islands.

Insect Pests

Black Stem Weevil or Borer.—Amongst insect pests that attack the banana the greatest trouble appears to be caused by the "black stem weevil," or "borer" (*Cosmopolotes sordidus*). This insect, or a closely allied species, occurs in many banana-growing countries, and is particularly destructive in Fiji. It attacks the "bulbs" of the plants by burrowing, eventually making them completely hollow and spongy, and causing young plants to wither and ultimately to die. Briefly, the appearance of the weevil and different stages in its life-history are as follows: the eggs are deposited on the tissues of the banana stem just above ground; the emerging larvæ burrow downwards and enter the bulb on which they feed, packing the tunnels they make with the gnawed tissue. The larva is a short, thick-set, wrinkled, legless, white grub, with a roundish, reddish-brown head, slightly over ½ in. in length. The pupa is dull white, ½ in. long, showing outlines of the

adult insect. The adult weevil is of a uniform dull black tint thickly covered with a fine, greyish buff pubescence, except on the back and wing covers ; the whole surface is thickly and finely punctured, and the back and wing covers are marked with regular parallel lines ; it is about ½ in. long and has the prominent proboscis characteristic of weevils. It crawls over the ground to deposit its eggs and is not known to fly. In the absence of natural enemies sufficiently powerful to keep it in check, the only method of controlling the insect is by trapping. The trap consists of portions of banana bulbs placed on the ground in places where the pest is present. These pieces should be examined at frequent intervals ; and any insects found in them should be destroyed, and the pieces should be burnt and replaced by fresh pieces.

Great care should be taken in selecting bulbs for planting to see that they are free from this pest. The presence of borers may be detected by examining a small slice from the bulb ; if this shows perforations filled with sawdust-like débris it may be assumed that the larvæ of the borer are present and the bulb should accordingly be rejected. The plantations should be kept free from banana stumps, which should be removed at an early stage after harvesting as they are likely to form a harbour for the pest.

Scab Moth.—A pest causing injury to the fruit in Fiji is a small moth. The injury, known as "Scab," at first takes the form of cracks in the skin of the fruit and these later spread and become discoloured patches which sometimes extend to the edible portion of the fruit causing it to decay. The apparent cracks are caused by the removal of strips of stem, eaten away by the small, thread-like larvæ of the insects. The attacks, if slight, detract from the appearance of the fruit and lower its market value ; and if severe they render the fruit unsuitable for export. This pest may be controlled by dusting each hand of young fruit with pyrethrum powder before the bracts have opened.

Nematode Worms

A nematode worm, sometimes known as eelworm or flaskworm (*Tylenchus* sp.) is a frequent pest of the "Gros

Michel " banana plant in several countries. These minute worms are present in the soil and attack the roots of the banana plant causing them to develop gall-like swellings, resulting in a diseased condition. The older leaves of affected plants become yellow and die, and the suckers of such plants have a stunted growth. This pest may be introduced in soil brought from infected areas, and it is essential when suckers are procured for planting that they should be obtained from soil free from the pest. As a measure of precaution all suckers used for planting from districts where the pest is known to occur should be disinfected by being steeped in a solution of corrosive sublimate for at least two hours, the roots having first been cut back close to the bulb and all adhering soil removed. The solution, consisting of 1 oz. of corrosive sublimate dissolved in 6 gallons of water, must be made in a wooden vessel and should be carefully protected when not in use as it is highly poisonous. The growth of affected plants should be stimulated by manuring, and the soil should be kept in good tilth to encourage roots to penetrate more deeply, as surface roots are the most liable to attack.

Subsidiary Banana Products

Although the cultivation of bananas, on a commercial scale, is chiefly concerned with the production of fresh fruit, there are several other banana products entering commerce on a small scale which are worthy of the consideration of planters, especially in new areas where facilities for the export of fresh fruit may not always be available. These products also afford a means for utilising fruit that is not of sufficiently high grade to pass inspection for export, or for employing local varieties that may suit the localities in which they are grown but are not of the kind required for export as fresh fruit. The most important of these subsidiary products are banana chips, meal or flour, which are prepared from the fully developed but unripe fruits ; and banana " figs " or evaporated bananas, for which ripe fruits are utilised.

Banana chips, meal or flour.—For the manufacture of these products the fruits are used in the green state,

when they have attained full size but are still hard, that is, before the ripening process has converted the starchy contents of the fruit into sugar. In the green state the banana is difficult to peel and, therefore, in order to facilitate the removal of the skin the fruits are immersed in hot water (176° F.) for a few minutes. The peeled fruits are then cut longitudinally into two pieces or are cut transversely into a number of small pieces, or "chips." For cutting and peeling the fruit a knife made of wood, bamboo or horn must be employed, or one of stainless steel, as an ordinary steel knife is tarnished on coming in contact with the fruit and causes discoloration of the finished product. The cut pieces are spread out in the sun to dry on mats or trays of bamboo or rattan and are turned about occasionally until thoroughly dry. If the climate is unsuitable for sun-drying, vacuum or machine driers, such as are used for copra, in which a temperature of from 160° to 180° F. can be maintained, are necessary. These driers are not only quicker but they give a superior product and obviate the risk of contamination by insects or dust. When thoroughly dry the fruit sections have a white biscuit-like appearance, and can then be readily reduced to meal by pounding in a mortar or by milling. To produce flour the meal is sifted through a sieve of fine mesh to remove the coarser particles. The finished product is packed in paper-lined wooden barrels for export; but as meal does not keep well in a tropical climate it is sometimes preferable to export the dried chips to be manufactured into meal and flour in the country of importation.

Banana flour consists almost entirely of carbohydrates and differs from wheat flour in not containing gluten. It is in consequence not suitable by itself for making bread as it will not "rise," but if mixed with wheat flour in the proportion of one of banana flour to three of wheat flour it is said to make a close-textured loaf, resembling ordinary brown bread, with a decided banana flavour.

Banana flour is used in the United Kingdom and in Continental countries for making various proprietary foods for infants and invalids and also in biscuit manufacture. The demand has not hitherto been large, probably on

account of the fact that regular supplies have not been forthcoming. Before the war a certain quantity was imported into Germany from the Cameroons, and the United Kingdom obtained supplies from Jamaica. It is probable that extended uses for this product could be found if regular supplies were available.

The yield of flour is approximately 20 per cent. of the weight of the green fruits, but varies considerably according to the variety of banana employed and local conditions. Prices range from 10*s.* to 15*s.* per cwt. in the United Kingdom.

Banana "figs."—For the preparation of evaporated bananas or banana "figs" the Chinese or Cavendish banana gives better results than the "Gros Michel" variety. The fully mature, ripe fruits are used; if not sufficiently ripe the dried product will be tough, whilst if too ripe it will be sticky and dark in colour. The precise stage of ripeness for drying to produce a satisfactory article is therefore a matter which requires some judgment. The peeling of ripe fruits presents no difficulties. The peeled fruit may be dried whole, or after being split into two pieces longitudinally or into small disc-like slices by cutting transversely. As in the preparation of "chips," an ordinary steel knife must not be used for cutting up the fruit, but one of stainless steel may be employed, or knives made from bamboo, wood or horn. The fruit prepared for drying should be spread on trays of bamboo or rattan, or of cotton cloth stretched on wooden frames, but should not be allowed to come in contact with steel or iron. If the climate permits of rapid drying by exposure to the sun the "figs" can be prepared by this process, but a quicker and more effective method is to employ a vacuum or machine drier for the work. The finished product, if well prepared, should be of a light yellowish-brown colour, but if the fruits are too ripe or the drying is too slow they are liable to assume a dark brown colour and are then not so attractive. The sugar contained in the ripe fruits is brought to the surface on drying, and, except in the case of certain kinds now being prepared by improved methods, the dried fruits present a sticky appearance which does not add to their attractiveness. Probably the most attractive

method of preparing the dried fruit for use as a sweet-meat would be to cut the fruit into disc-like slices and coat the slices with sugar during the drying process. This would result in a "crystallised" product similar in appearance to crystallised ginger which is in constant demand and finds a ready sale with confectioners. The addition of sugar would, however, render the product liable to excise duty in the United Kingdom. The appearance of the dried whole fruits might possibly be improved by a light dusting with banana flour before packing. For export purposes dried bananas are usually packed in wooden boxes, like dates. If a paper lining is used it should be of waxed paper, as ordinary paper would adhere to the fruit. For retail purposes the fruit is usually repacked in cartons similar to those used for the better kinds of dates and figs. There appears to be no reason why dried bananas should not become as popular as Turkish figs or dates but hitherto the demand for them has been limited. It is probable that in countries where they have to compete with the fresh fruit the demand will never be great, unless confectioners and manufacturers of chutnies and sweet pickles can be induced to utilise them in their various preparations. In countries where the fresh fruit is not procurable they should find a good market, especially if an improved appearance could be given to them.

The principal country producing banana "figs" is Jamaica, where several factories are engaged in their preparation. The quantity annually exported fluctuates considerably according to the demand for fresh fruit and the amount of fruit available. The following table shows the quantities and values of the Jamaica banana "figs" exported during the past ten years :

Year.	*Packages.*	*Value £.*
1914	2,576	1,858
1915	789	831
1916	1,012	776
1917	1,154	570
1918	6,526	6,680
1919	19,937	25,433
1920	7,670	11,774
1921	—	5,109
1922	3,802	3,334
1923 (Jan.–Sept.)	2,257	1,533

The comparative ease with which dried bananas can be exported as compared with the fresh fruit should render this form attractive to the small grower, especially in places where shipping facilities for the export of fresh fruit are not available. The large growers might also give this product more attention as there is considerable waste of fruit at ports where bananas are shipped owing to unsuitable fruit being rejected. If the co-operation of confectioners and manufacturers could be obtained, and a regular supply of carefully prepared banana figs or slices of an attractive appearance could be assured, a much larger output could probably be absorbed.

Banana fibre.—The stems of bananas which have fruited are cut down after the fruit has been harvested and, with the leaves, form what is known as banana "trash." Large quantities of trash are available in countries where the acreage of bananas is large and it is usual to return this to the soil of the plantations as manure. In cases where the fresh fruit is exported in crates, a certain amount of leaf trash is used as packing, but this is relatively small. As the stems contain a fibre, proposals have from time to time been made for extracting it for use as a cordage fibre, and small quantities have been obtained for local use but not on a commercial scale. It is found that the fibre obtained from plants which have fruited is inferior in quality to that obtained from wild bananas or from the allied species, *Musa textilis*, which furnishes manila hemp. Experiments carried out in Jamaica showed that the yield of fibre from stems of fruiting bananas was only 1·44 per cent., so that unless prices for fibres of this class ruled very high it would hardly pay for the labour involved in collecting the stems and extracting the fibre.

Proposals have also been made for utilising banana stems for paper pulp and this would appear feasible in countries where large areas are under bananas, but in view of the low yield of pulp the returns would be small. In order to obtain 1 ton of paper it is estimated that it would be necessary to handle 132 tons of the cut stems, and the resulting paper would not be of very high quality.

A British patent has recently been granted covering a process for the manufacture of cellulose pulp from

banana trash by non-chemical means. By this process the trash is crushed between rollers which reduce the moisture content from about 90 per cent. to 55–75 per cent. The liquid being removed, the remaining trash is reduced to pulp in a pulping machine, and is afterwards cooked for from 3 to 6 hours in a boiler under pressure. It is afterwards transferred to a breaking and beating machine where it is washed and the gummy substances removed in a current of water. The recovery of the cellulose completes the process and it is claimed that the resulting product is stronger and of lighter colour than if soda had been employed.

Potash.—It has been shown that the ashes of banana stalks and skins contain respectively 45·9 and 57·16 per cent. of potash, equivalent to 1·14 and 1·05 per cent. in the fresh stalks and 13·75 and 9·03 per cent. in the dried material. Dried banana stalks are thus as rich in potash as commercial kainit and they are therefore of considerable value as manure. The stalks and trash used for packing should therefore be returned to the banana plantations, or, if this is not possible in areas where wilt disease is present, they should be burnt and the ashes returned to the soil.

Banana Cultivation in the Empire

The following is a brief summary of the present position of banana cultivation in countries of the Empire. In most of the tropical regions the banana is grown as a food crop for local consumption. The question as to whether the cultivation could be extended in these countries so as to provide a surplus for export depends upon there being suitable land available near a port, together with the necessary labour supply and shipping facilities with cold-storage accommodation for exporting the produce. The possibility of commencing an industry in banana flour or dried bananas, where facilities for exporting the fresh fruit are not available, should not be overlooked.

British West Indies.—Jamaica is now the centre of the West Indian banana trade and is also the principal banana-exporting country in the world. The best soil for bananas is found in the Portland and St. Mary parishes where enormous crops are produced. On the plains of St.

Catherine and in Vere the crop is grown under irrigation. The trade in Jamaica has prospered during recent years owing to the Panama disease in Central America having checked the supply from those countries which produce the bulk of the world's output. This disease is present in Jamaica but is controlled by the strict system of inspection and quarantine which has been in force during the past ten years. The export of the fresh fruit from Jamaica in the year 1923 was 12,455,310 bunches, valued at £2,265,309 ; the export has on several occasions exceeded 16 million bunches a year, but the value has never previously reached £2,000,000. For the last 22 years the average export has been 11,104,866 bunches and the average value £1,001,460 or 1*s.* 8*d.* per bunch, whilst in 1923 the price per bunch reached an average of 3*s.* 6*d.*

The success of the banana industry in Jamaica is largely due to the part played by the United Fruit Company, the Atlantic Fruit Company, and the Jamaica Fruit and Shipping Company, especially the first-named, which operates on a very large scale. The bulk of the trade is with the United States and Canada, but a considerable amount of business is done with the United Kingdom and the Continent of Europe by Messrs. Elders & Fyffes, Ltd., a British Company managed in England, but in which the majority of the shares are held by the United Fruit Company.

In addition to the fresh fruit there is a small trade done in banana meal and a considerable trade in dried bananas. There was an export of 20,000 boxes of the latter, valued at £25,000, in 1919–20, but, owing to a shortage of fruit, the export for 1921 fell to 8,000 boxes. This trade utilises low-grade bananas that are not accepted for export as fresh fruit or that are produced at some distance from the shipping port.

Bananas were formerly exported on a small scale from Trinidad and also from Barbados and Dominica, but this trade has now almost ceased. Recently a proposal was made by a syndicate of British capitalists to create a banana export industry in Dominica. Owing to the difficulties of internal transport in this island it was not found possible to export the fruit at the prices offered by the

syndicate and the proposal did not materialise. As a result of the enquiry, a small demonstration plot of 200 plants, spaced 12 × 12 ft. in rows 16 ft. apart, has been established to illustrate improved methods of cultivation in case the subject of a banana industry should be reopened in the future.

British Honduras.—The banana trade of British Honduras is but a minute part of the great Central American and Jamaican industry developed by the United Fruit Company. The output of bananas in British Honduras is relatively small, being less than 500,000 bunches a year. The fruit is grown principally at Stann Creek Valley, Riversdale and Monkey River; and the coasting steamers of the United Fruit Company call weekly on a fixed schedule to take the produce to New Orleans. The banana industry in the Stann Creek Valley is rapidly declining, chiefly on account of Panama disease. The Government have taken steps to prevent the spread of the disease from the Stann Creek Valley, and with strict quarantine and sound methods of production it should be possible to continue banana growing on suitable new lands in areas like Monkey River and Sittee River, where the disease has not yet shown itself. The prices paid for fruit are low compared with those paid in Jamaica; nevertheless, these prices bring in a profit to the small grower, provided he can secure land of high productive value, free from disease. The quality of the fruit in British Honduras is quite satisfactory, though the yield per acre is not so large as in Jamaica, Guatemala and Costa Rica. But if trenching and mulching were practised, it could easily be made so; this consideration, however, depends upon labour supply and the prices paid for fruit. The banana plantations in British Honduras are sometimes liable to damage by floods, blowdowns and cold weather; but these are not so disastrous as hurricanes.

British Guiana.—The flavour of the local bananas, of which there are several varieties, compares favourably with that of those exported from other places, and at one time it was thought that an export trade might be built up. The local banana is said, however, to be too delicate to stand transport. Other varieties, such as the "Gros

Michel," can be grown, however, on warm, well-drained lands, rich in humus. If, therefore, facilities for transport to a shipping point were available and the present lack of labour could be overcome, something might be done towards developing an industry.

Australia.—The cultivation of bananas in Australia, as a commercial proposition, is now carried on chiefly in Queensland, but, owing to the attention that has been recently given to sugar, large areas that were formerly planted with bananas have now been devoted to the latter crop. In the Tweed River district of the North Coast Division of New South Wales the banana is also grown as a commercial crop, but "bunchy top" disease has checked development in recent years. According to the *Yearbook of the Commonwealth of Australia for* 1923 the following are the banana areas and yields for the fiscal year 1921–22:

	New South Wales	Queensland.	Western Australia.	Commonwealth of Australia.
Area (*acres*)	4,570	9,873	7	14,450
Yield (*bushels*)	650,300	1,307,090	785	1,958,175
Value £	368,500	363,080	1,178	732,758

With the extension of the main coastal railway to Cairns, which is shortly to be completed, very large areas of land that are admirably adapted for the culture of bananas will be made available, and in all probability there will be an extension of the areas under bananas in Northern Queensland. The Mackay district has been favourably reported on by the Queensland Director of Fruit Culture in this connection. The proposed railway would permit of bananas being landed in Sydney with only one handling at the border. Bananas are said to yield a profit in Queensland of from £20 to £50 an acre from the third year's crop. The import duty of 1*d.* per lb. on bananas entering the Commonwealth, imposed in 1921, should stimulate the production of the home-grown fruit. The following table shows the quantities and values of the bananas imported into Australia during the two fiscal years 1920–21 and 1921–22:

From	1920–21. Quantity (*centals*).	1920–21. Value £	1921–22. Quantity (*centals*).	1921–22. Value £
Fiji	88,676	84,649	2	2
Netherlands East Indies	16,456	14,146	18,292	20,610
Other countries	504	370	317	185
Total	105,636	99,165	18,611	20,797

Fiji.—The cultivation of bananas for export as green fruit to New Zealand is a considerable industry; large quantities were also formerly exported to Australia. The fruit is grown by Europeans, and by small cultivators, both Indian and Fijian, who sell their fruit to exporters. The large grower may ship his own fruit, but sometimes he sells to the exporter.

The fruit is cut and shipped green, and is subject to inspection during the loading into the steamer, in accordance with regulations, made under the Fruit Export Ordinance, which, among other things, require that it shall be of a certain quality, shall not have been cut more than a specified number of days before shipment, and that the plants from which it was cut have been treated according to the regulations in force for the time being under the Diseases of Plants Ordinance.

The chief banana areas on Vitilevu are on the Rewa River; the Tailevu coast; on small creeks around Suva, and between that port and Navua; and on the Navua River and the Sigatoka River. A small quantity of fruit is grown on the South Coast of Vanualevu, and around Levuka on Ovalau.

Suva is now the only port of shipment, and the fruit for export must therefore be grown within reasonable distance of that port. Levuka, Momi and Savusavu Bay were also used formerly when fruit was plentiful in those neighbourhoods.

At present new shippers can only be given space in the exporting steamer at the expense of existing shippers, and the industry is therefore only capable of limited expansion. Whilst very remunerative under certain conditions, the industry is surrounded by risks, and can only be embarked on with a good chance of immediate success by persons with much local experience.

The export for 1921 amounted to 582,925 bunches, valued at £73,600, of which New Zealand took 485,129 bunches and Australia 97,796. The export for 1922 amounted to 358,122 bunches, valued at £45,717, of which 354,215 bunches went to New Zealand and 3,895 to Canada. The import duty has now practically stopped the export to Australia. The trial shipment to Canada

was not satisfactory owing to the unsuitability of the steamer, but with suitable shipping there is a possibility of a satisfactory trade with that country. The imports of fresh bananas into Canada during the 4 years ending with 1922 were as follows:

	1919.	1920.	1921.	1922.
Total bunches . . .	1,665,414	1,844,559	1,706,288	2,159,860
Total value . . .	$3,716,713	4,947,007	5,415,511	5,211,098

Practically the whole of these imports were obtained through the United States of America, and in addition there was a small import of dried bananas from Jamaica. It will be seen, therefore, that a considerable market exists in Canada for bananas which might be secured by Fiji exporters.

British Solomon Islands Protectorate.—Bananas have been exported from the islands to the Australian markets and have commanded prices equal to those obtained for the best Fiji fruit. "Gros Michel" bananas from the Solomons have been pronounced by a Fiji expert to be equal to anything that Fiji can produce. The "Cavendish" banana is grown in abundance in native gardens.

Malaya.—The banana can be produced so cheaply in this country that it should be possible to ship fresh fruit to the Southern and Western States of Australia; and, provided ships on the Singapore-Australian route were fitted with special refrigerating space, there appears to be no reason why a profitable trade should not be developed between the two countries. The fruits can be purchased in the local markets at considerably less than a cent each and, if delivered in good condition, could probably be sold in Australia at a price equivalent to 5 to 6 cents.

Ceylon and India.—Bananas are a subsidiary crop in opening up land for coconuts in the North-West Province of Ceylon, whilst in parts of the Kegalle and Dumbara districts they form the chief native cultivation. Several local varieties are grown, including "Gros Michel" and "Cavendish," but the production is only equal to the local demand and there is no export.

In India the cultivation is general all over the country except at high elevations, and bananas are an important

factor in the food supply of the people. The crop is consumed locally and there is no export.

Cyprus.—Bananas are grown as a garden crop and the cultivation will probably extend. Special varieties have been introduced by the Agricultural Department and have been distributed to growers.

Kenya.—Bananas are grown to great perfection over most of the Colony, being largely cultivated by the Africans, and with some tribes the fruit forms an important part of their food supply. Some of the finer flavoured varieties are grown to some extent by the European farmers, and bananas always find a ready local market, though scarcely on a sufficiently remunerative scale to warrant their being planted more extensively until export and a foreign market can be arranged for.

South Africa.—In the Union of South Africa bananas are commonly grown as ornamental plants. In Natal they are also grown on a commercial scale for fruit, although not extensively, the total production barely meeting home requirements. There is a small export of an annual average value of about £500 a year, but in 1922 this reached a value of £800.

West Africa.—In view of the favourable situation of the West African Colonies as regards nearness to the home market, the possibility of developing a banana industry in this region would appear to be worthy of serious consideration, especially in view of the check to the production of bananas in Central America which has resulted from the spread of the Panama disease. The French have established a small industry in French Guinea which exports fresh fruit on a small scale to France, and before the war the Germans had devoted a good deal of attention to establishing a banana industry in the Cameroons and had commenced to export fruit to Germany. No attempts appear to have been made to export bananas from any of the British West African Colonies, although bananas are generally grown for local use, and this is probably due to the overwhelming importance of oil-palm products and cocoa in these countries. In view of the competition in oil-palm products which will no doubt soon result from the cultivation of the oil-palm in the East and the declining prices

Plate VIII.—A Crop of Bananas arriving at the Estate Railway, Tiko, Cameroons

Photo by F. Evans, Supervisor of Plantations, Cameroons.

for cocoa, the consideration of the banana as a possible subsidiary export crop would appear to be desirable.

THE BRITISH SOLOMON ISLANDS

THE Solomon Islands Protectorate, though one of the less known parts of the British Empire, is by no means among the least attractive or from a historical point of view the least romantic. The Islands have assumed some importance in recent years, owing to the extension of coconut cultivation for the preparation and export of copra, but as will be shown in this article they are also of much interest in other ways.

Several writers have dealt with various aspects of the Islands, and an excellent general description of the region was given nearly thirty years ago by Mr. H. B. Guppy, M.B., F.G.S., in his work *The Solomon Islands and Their Natives*. The present article is based largely on Mr. Guppy's observations and on the information furnished in the official *Handbook of the British Solomon Islands Protectorate*, a new edition of which was recently issued at Suva, Fiji.

I. Historical and General

Mr. Guppy's work affords much interesting information on the geology, botany, meteorology and other natural features of the Islands. The author also discusses the native population at considerable length, and he suggests that the earliest inhabitants were of the same stock as the present natives of the Andaman Islands and certain other parts of the East Indies, on which supposition he observes that the physical and linguistic characters of this race have since become fused with those of other peoples who reached the Islands from Malaya, Micronesia and Polynesia. This aspect of the question is, however, largely a matter of speculation, and for the present purpose the history of the Solomons commences in 1568, when the Spanish explorer Alvaro de Mendana, who had sailed from Peru with the object of discovering a southern continent,

visited several of the islands in the group and gave them Spanish names which they still bear. Nearly thirty years later he again sailed from Peru, this time with a commission to colonise the islands, but he failed to locate the Solomons proper, and endeavoured to form a settlement (named by him Graciosa Bay) on the largest island of the Santa Cruz Group, which now forms part of the British Protectorate. Mendana and others of his party shortly afterwards died, and it was found impossible to carry the colonisation to a successful issue; the survivors accordingly re-embarked, under the command of Pedro Fernandez de Quiros, and sailed westward with the intention of reaching San Cristoval, the nearest large island of the main group. For some reason—probably a mistake in reckoning, coupled with bad atmospheric conditions—they could not find it, and were compelled to change their course and proceed to Manila.

This failure to find San Cristoval had a remarkable sequel, for though Quiros subsequently made new discoveries in the southern Pacific (including the island of Espiritu Santo in the New Hebrides) and other explorers visited outlying parts of the present Protectorate in the following century, the Solomon Islands proper were relegated to obscurity for nearly two centuries, and their very existence became a matter of doubt. The rediscovery of the group was carried out in 1767–69 by Carteret, de Bougainville and de Surville. Further exploration of the region followed in 1781 and 1788 under Spanish and British auspices, and subsequently numerous individual islands were found and named by various navigators. The islands continued to be the scene of exploration and adventure up to the end of the nineteenth century.

The particulars quoted above explain the variety of languages met with in the European names of the islands. In the year 1893 a British Protectorate was declared over the islands of the Southern Solomons—comprising Guadalcanal, Savo, Malaita (or Mala), San Cristoval (or Bauro), and the New Georgia Group with its dependencies—and also over the Island of Treasury at the southern entrance of the Bougainville Straits; whilst Ysabel, Choiseul, the islands in Bougainville Straits, and the island of Bougain-

ville itself, were assigned to Germany. In 1898 and 1899 the islands of the Santa Cruz Group, including Utupua, Tucopia, Vanikoro, the remote islands of Cherry and Mitre, Sikiana, and the islands of Rennell and Bellona were added to the Protectorate; and in 1900 Ysabel, Choiseul, the islands in the Bougainville Straits south and south-east of the main island of Bougainville, and the atoll group of Ongtong Java (or Lord Howe's Group), were transferred by treaty from Germany to Great Britain.

The present Protectorate is subject to the jurisdiction of the High Commissioner for the Western Pacific Islands. It extends in a north-westerly and south-easterly direction for 900 miles, from Bougainville Straits to Mitre Island, and north and south from Lord Howe's Group to Rennell Island, a distance of 430 miles. The three largest islands, viz. Guadalcanal, Malaita and Ysabel, each contain about 2,000 square nautical miles, and if another 200 square nautical miles be added for the Santa Cruz Group and adjacent islands, the total land area of the Protectorate amounts at a moderate computation to about 9,500,000 acres, i.e. an area nearly twice as large as Fiji.

A British Resident Commissioner was first appointed in 1896, at which time the resident white population amounted to fifty. Planting operations by white men had at that time scarcely been commenced, but it was already recognised that the Solomons were eminently suited for extensive cultivation of the coconut palm.

When the Protectorate was first established the Resident Commissioner engaged as police six Solomon Islanders who had been domiciled for some years in Fiji. Up till then the policing of the Group had been undertaken by means of gunboats, but it had been clear for a long time that whilst the moral effect of naval vessels was very great amongst the beach tribes, the influence of landing parties in overawing the bush natives was almost negligible. When Gizo station was opened in 1900, a force of twenty-five armed constabulary was stationed there, and subsequently performed useful work in quelling the head-hunters of the Roviana and Marovo Lagoon and other disturbed parts of that district. With the appointment of a District Officer on Malaita the force was increased to sixty-

six; and in 1923 the establishment consisted of one hundred and fifty-three of all ranks.

The climate of the Protectorate cannot be described as healthy, malarial fever and dysentery being prevalent (the latter chiefly among natives). The direction of the prevailing wind is from the south-east from April to the beginning of November, whilst from November to the end of March calms may be expected, with an occasional spell of heavy north-west weather which sometimes continues for three weeks at a time. Hurricanes, however, are unknown.

The temperature at sea-level varies from an occasional maximum of about 92° F. to a minimum night temperature of 73° F. An early morning temperature of 49° F. has been recorded at an altitude of 6,000 ft. on the mountains of Guadalcanal.

The geology of the Islands has not yet been the subject of detailed study, but an interesting general description was furnished by Mr. H. B. Guppy in the volume already mentioned, and a more detailed account by the same author is given in *The Solomon Islands: Their Geology, General Features, and Suitability for Colonisation.* Although Mr. Guppy had to limit his investigations to a few of the islands, those that he examined represented the different types to be found in the group, and his narrative emphasises the extreme geological diversity that exists. The region is mountainous, and predominantly of volcanic origin, though many coralline and other later formations are met with. Regarding the island of Guadalcanal, on which the author was not able to land, he says: "Few visitors to these regions could fail to have been impressed with the grandeur of the south-east portion of this large island. Viewed from the south, a few miles from the shore, its lofty mountains rise up one behind the other, their summits lost in the clouds. Every variety of mountain profile is represented in the elevated region; and we may infer a corresponding diversity in geological structure."

The Protectorate still contains one active volcano, that of Tinakula, a small island about twenty miles north from Graciosa Bay in the Santa Cruz Group. Tinakula is rather more than a mile in diameter and rises abruptly

from the sea to a height of 2,200 feet. The volcano is frequently to be observed in eruption, and its northern side is quite devoid of vegetation in consequence of the hot ejecta which are spilled down the side. At Parasso in the Island of Vella Lavella, and at Narovo and Savo Islands, there are craters which are in the solfataric stage, and other places, such as Kulambangra, Rendova and Murray Island, show extinct volcanic cones in more or less advanced stages of erosion. Fumaroles at Parasso, Narovo and Savo emit aqueous and sulphurous vapours.

Seismic disturbances are common in the Protectorate and have on occasion been very severe. The entire population of Savo have several times been on the point of abandoning the island, so heavy have been the earthquake shocks in that locality. The Shortland Islands experience frequent earthquake shocks, being situated in the vicinity of the Island of Bougainville on which is the active volcano of Bagana.

The native population of the islands is estimated at 150,000, but it is not possible at present to arrive at any trustworthy figure. The most thickly peopled island is Malaita, which is thought to have a population of between 50,000 and 100,000. The non-native inhabitants of the Protectorate are few; in March 1922 there were under 500 whites with a small number of Chinese and other immigrants.

II. Fauna and Flora

The fauna and flora of the Protectorate are of great interest, but although Mr. Guppy carried out much useful botanical work, the flora is still very imperfectly known, and awaits the labours of a skilled botanist with ample time to devote to his task. Many valuable timbers are known to exist, and numerous plants are employed for various purposes by the native population, but apart from the coconut palm (see p. 340) only a few trees are at present of any special economic interest. Among these, however, may be mentioned that yielding "ivory nuts," *Coelococcus salomonensis*, Warb. (= *Sagus amicarum*), a species of sago palm, which is peculiar to the Solomons, and though not cultivated grows plentifully

in swampy ground unsuited for coconuts or other crops. The tree, which bears fruit but once and then dies, is believed to require some ten or fifteen years to attain maturity. There is no danger of the extermination of the trees by wasteful destruction, as in any case they are in a dying condition when the nuts are collected and others spring up from seeds left on the ground. The nuts have been exported for the last forty or fifty years, and like "ivory nuts" from other sources, are used in the manufacture of buttons and other small articles.

A tree of possible importance is the "Nauli" (*Canarium commune*, L.), the "Java almond tree," closely allied to *C. luzonicum*, Miq., of the Philippines, the source of the well-known Manila elemi of commerce. The Nauli tree yields an oleo-resin of some interest, a sample of which was examined at the Imperial Institute in 1921 and is described in this BULLETIN (1921, **19**, 457). Another resin from the Protectorate, yielded by the tree *Agathis macrophylla*, Lindl. (a near relative of the Kauri pine of New Zealand), has also been examined at the Institute and found to be of interest as a possible substitute for the "soft Manila copal" of the East Indies, which is said to be derived from *Agathis alba* and is used in the manufacture of spirit varnishes. A summary of the report made on the resin will be found on p. 294 of the present number of this BULLETIN.

Among the timber trees may be mentioned "dilo" (*Calophyllum Inophyllum*), of which the available supply is extremely large, and *Afzelia bijuga*, the wood of which is stated to be impervious to the attacks of white ants and almost immune from those of *Teredo navalis*, and may thus prove a useful timber for general tropical use, shipbuilding and wharf construction.

The only large land mammals which occur in the Solomons are the native pig and wild dog. In the mountains of Guadalcanal the wild dogs are said to hunt in packs, and to have run down and killed men. On the same island, two closely allied species of gigantic bush rats, of the size of large rabbits, are found, one being arboreal in its habits. Another smaller species of rat, peculiar to Guadalcanal, is known, and the small rat of the Pacific swarms everywhere

in the neighbourhood of trading stations. The marsupial *Cuscus orientalis* occurs throughout the Solomons proper, except perhaps on San Cristoval, but is not known to occur in the Santa Cruz Group.

Bats, both insectivorous and frugivorous, are abundant, several species being peculiar to the Solomons. Whales of various kinds visit the islands at certain seasons ; the dugong is frequently met with, and blackfish and porpoises abound.

Birds are plentiful, and some are of great beauty, although the birds of paradise of the Papuan region do not extend their range so far as the Solomons. Cockatoos, parrots and lories abound, and also pigmy parrots of the genus *Nasiterna.* Kingfishers of about ten species are known, the largest and most conspicuous being the beautiful *Halcyon saurophaga.* Eagles, ospreys, hawks and buzzards are met with, as well as numerous species of the smaller short-winged hawks. A crow is found on Guadalcanal and Ysabel, and the hornbill occurs commonly, except on San Cristoval. Fruit-eating pigeons are very numerous in some localities, and Guadalcanal is notable as containing a species of long-tailed pigeon (*Turacaena crassirostris*) which has not been met with elsewhere.

Mention may also be made of the megapode, a bird allied to the brush turkey of Australia. This bird, about the size of a large pigeon, lays an egg the size of a duck's egg. The eggs are buried by the bird about two feet deep in the sand, and left to hatch out by the natural heat of the ground. In some places, especially on Savo and Guadalcanal, the natives keep patches of sand clear for the birds ; these " laying yards " being divided into portions which belong to different owners.

Crocodiles are common, generally frequenting the sea coasts and mangrove swamps. The large monitor lizards reach a length of four feet and are great enemies to keepers of poultry, as they devour the eggs. Smaller lizards and geckos are always in evidence, and many species of snakes abound, some of them venomous. The rivers of Guadalcanal and other islands are frequented by a gigantic bull-frog (*Rana guppyi*).

III. Economic Development

Agricultural progress in the Solomons is hindered by lack of an adequate labour supply. The only labourers at present available for employment on plantations are the natives of the Protectorate itself, and although recruiting for the Queensland plantations ceased in 1903 and that for work in Fiji in 1910, the local labour supply is totally inadequate for present requirements.

Labourers under contract engage for a term of two years. About two-thirds of them come from the Island of Malaita; the natives of the western part of the Protectorate have never engaged in any number for plantations, and only to a limited extent on board coasting vessels. The total expense incurred in the recruiting, maintenance, and return of a Malaita "boy" is estimated to be at least £60 for a two years' contract.

In view of the existing circumstances, planters in the Protectorate recognise that it is unwise to devote capital to products requiring a plentiful, regular and to some extent skilled labour supply. They therefore devote their attention mainly to coconuts, which under proper supervision require only unskilled labour, and not so much even of this as many other crops. The cost of coconut cultivation in the Solomons varies considerably according to the locality, climatic conditions, shipping facilities and distance from recruiting grounds. Individual planters can often develop their properties more cheaply than large companies, but much depends on the nature of the soil selected. Rich alluvial flats of a swampy nature are estimated to cost £50 to £60 per acre to bring to maturity; foothill slopes and undulations about £40 to £50, and sandy or coral land (usually conducive to rapid growth and requiring but little weeding) about £30 per acre. It is considered that under present conditions an estate cannot become self-supporting until about the eighth or ninth year, and that dividends on capital are not to be expected much before the eleventh or twelfth year.

In spite of all difficulties, the formation of coconut plantations has proceeded continuously since the establishment of British authority in the Protectorate, and it is

estimated that at the present time the area thus cultivated and owned by persons other than natives amounts to some 30,000 acres. The trees are as a rule planted on the quincunx system, at a distance apart of thirty-three feet, this method giving about fifty trees to the acre. Closer planting is not considered to be adapted to the vigorous growth which coconut trees exhibit in the Solomons.

Copra forms by far the largest part of the exports from the Protectorate, the quantity shipped during the year 1921–22 amounting to no less than 12,109 tons, but coir (the fibre obtained from the husk of the coconut) is not manufactured, the labour necessary for its production being usually considered to be more advantageously employed in the preparation of copra.

A few plantations of Para rubber (*Hevea brasiliensis*) have been formed, and some of the larger trees have yielded rubber of excellent quality. The comparatively low price obtained and the scarcity of labour have, however, been obstacles to the development of this industry.

A plantation of cotton (grown partly in connection with coconuts) was formed some years ago on the north coast of Guadalcanal; Caravonica cotton was at first grown, but preference was given later to another variety, raised on the plantation itself, to which the name of "Mamara" had been given. Samples of both kinds were forwarded to the Imperial Institute in 1912 and were found to represent saleable products of fair quality.

Sisal hemp has been experimentally grown on one plantation, but not with entire success, and it is considered probable that the soil or situation was unsuitable for this crop. It is thought that in general the climate is too damp for the production of Sisal hemp of satisfactory quality. Manila hemp (*Musa textilis*), grown from plants introduced from the Philippines, and extracted locally, has been favourably reported on by the Imperial Institute (see this BULLETIN, 1915, **13**, 23).

Next to copra, although far below it in value, the chief exports from the Islands in recent years have been trocas shell, ivory nuts, timber and bêche-de-mer. Timber has only appeared in the returns since 1920, but its value amounted in 1921–22 to over £3,400.

The total value of the exports from the Protectorate, which was about £89,000 in 1910–11 and 1911–12, rose in 1919–20 to £212,500, and in 1920–21 to as much as £336,500, of which over £300,000 represented copra. A fall to £182,887 occurred in the following year, but in 1922–23 the total rose again to about £231,698, including £209,387 for copra and £14,394 for trocas shell.

The revenue of the Protectorate, which was only about £14,000 in 1910–11, reached £56,741 in 1922–23; the expenditure in the latter year being £52,472.

NOTES

Ceylon Rubber Research Scheme.—The Annual General Meeting of subscribers to this Scheme, whose objects have already been described in this BULLETIN (1923, **11**, 99; 1924, **12**, v), was held at Kandy, Ceylon, on March 13, 1924. At the present time the contributors to the Scheme represent slightly over 60 per cent. of the total rubber acreage in Ceylon, or approximately 82 per cent. of the European-owned estates.

The staff in Ceylon now consists of an Organising Secretary, Chemist, Mycologist and Physiological Botanist.

The establishment on Culloden Estate, Neboda, which had been used for experimental purposes by the Rubber Growers' Association, was handed over to the Scheme and adopted as the nucleus of a research station. The accommodation, however, was found to be inadequate for the requirements of the necessary staff, and a fully equipped chemical, mycological and botanical laboratory has therefore been recently erected, and two additional bungalows are being built.

Notwithstanding the limited facilities hitherto available, a considerable amount of useful work has been accomplished in Ceylon in the investigation of a number of problems of immediate practical importance to the planting community. The Chemist, Mr. T. E. H. O'Brien, B.Sc., A.I.C., has been largely occupied with problems connected with the preservation of latex, and at the present time is engaged on an extensive series of experiments dealing with the smoking of rubber. Much of the smoked sheet of Ceylon is at times affected with "rust" and a careful investigation of the cause has been made by Mr. O'Brien in collaboration with Mr. M. Park, A.R.C.S., the Mycologist to the Scheme.

The results show conclusively that "rust" is brought about by the action of micro-organisms, and that it develops when surface drying of the sheets is too slow and when badly ventilated smoke-houses are used. Mr. Park has also done useful work in connection with the use of disinfectants for preventing bark rot. The penetration of various antiseptics has been studied in order to determine their effect on the bark of the tree, and a series of field experiments designed to ascertain their effect on the causative fungus has been begun. It would appear from the preliminary results already secured that the regular application of antiseptics materially reduces the incidence and development of bark rot, but in no case entirely prevents it. A series of manurial trials is in progress in order to ascertain if manuring has any effect on the occurrence of secondary leaf-fall and pod disease. So far it would appear that manuring may be beneficial in this connection but that the experiments will have to be continued for several years before results are obtained on which any recommendations can be based.

The Physiological Botanist, Mr. R. A. Taylor, B.Sc., has begun a comprehensive investigation of brown bast and has had the opportunity of studying this disease in Java and Malaya. The exact cause of the disease is still undetermined, but its occurrence in Ceylon is greatly influenced by environmental factors. The change-over system of tapping and subsequent bark renewal are being carefully studied. Work is also being done in regard to seed selection, bud-grafting and the use of cover crops in rubber cultivation.

In addition to carrying out the secretarial work in Ceylon, the Organising Secretary, Mr. J. Mitchell, A.R.C.S., visits estates principally in connection with questions relating to the methods of controlling diseases and of dealing with the preparation of rubber. During the year he visited 81 estates and submitted full reports to the agents and superintendents in each case. The results of these visits show that brown bast, *Fomes lignosus*, bark rot and patch canker are still the most serious rubber diseases in Ceylon. The creation of a close link between the Scheme and the estate superintendents by visits such as these and in other ways is regarded as of considerable importance.

The principal investigation in progress at the Imperial Institute is a study of the variability of plantation rubber which was commenced under the previous Scheme. In connection with this enquiry a comprehensive series of samples has been prepared at different times of the year

under standard conditions on certain selected estates in representative rubber-growing districts of Ceylon.

In connection with the experiments in Ceylon on the preservation of latex, several samples of latex preserved with ammonia were examined during the year, and vulcanising and mechanical tests carried out on rubbers prepared from them at the Institute (see this BULLETIN, 1924, **22**, 136). Arrangements were also made for technical trials to determine the suitability for paper-making of a specially prepared set of samples of latex preserved with caustic soda and ammonia.

A considerable amount of work has also been done at the Institute on the examination of rubbers by new processes. Among the investigations of a variety of samples received from Ceylon and elsewhere, special mention may be made of the detailed examination, in comparison with plantation rubbers, of rubber prepared by the Hopkinson Sprayed Latex Process which has for some time been receiving considerable attention from the rubber industry in the United States. A full report of this investigation will be found in this BULLETIN (1924, **22**, 141).

As a result of a discussion with the Director of the Research Association of British Rubber and Tyre Manufacturers, a number of special tests are being made to investigate the statement of the manufacturers that plantation rubber is still not so suitable as fine Para rubber for certain purposes.

On completion of the examination of the rubbers prepared in connection with the previous Scheme it was considered advisable to review, in the light of the experience gained, the whole question of the tests carried out and the methods employed. The tests have now been modified and extended, one of the principal alterations being that in addition to testing in a rubber-sulphur mixing as generally practised, samples are now submitted to examination in a mineral mixing in order to obtain fuller information as to the results obtainable under manufacturing conditions. Special attention is also being given to the possibility of including experiments comparing the behaviour of different rubbers during the various processes of manufacture. The London Committee is in communication with the Central Rubber Station in Java and with the American Chemical Society regarding the testing of rubber and it is hoped ultimately to arrange for more uniform methods to be adopted by rubber investigators.

The work of the Scheme is being published in the form of bulletins which are distributed to all subscribers and to members of the Rubber Growers' Association, and, in

order to keep subscribing estates in Ceylon in close touch with the work a quarterly circular dealing with the work of the officers of the Scheme and with matters of interest to rubber growers has been begun. Reports of the work carried out at the Imperial Institute in connection with the Scheme are published from time to time in the *Bulletin of the Imperial Institute.*

Agricultural Progress in the Sudan.—Interesting information regarding the progress made in agricultural industries in the Sudan during the past year is given in the *Annual Report* of the Director, Commercial Intelligence Branch, Central Economic Board, Sudan Government, for the year 1923–24. The outstanding events of the year were the progress of the work on the Makwar Dam and the Gezira Cotton Growing Scheme, and the completion of the railway to Kassala in the Eastern Sudan. As regards the Dam, which is situated 170 miles south of Khartoum on the Blue Nile, near Sennar, the most difficult part of the work, namely, the "sudding" of the deep eastern channel, has been successfully initiated. Much work has been done on the canalisation of the area to be irrigated, and the scheme is to be completed in time for the irrigation of the 1925–26 cotton crop. The Sudan Government will be enabled to complete these works by an undertaking on the part of the Imperial Government to guarantee the principal and interest of loans to a total value of £13,000,000. The initial area of cotton aimed at by the works is 100,000 acres, estimated to yield 80,000 to 100,000 bales of lint. The Dam, however, commands an area of 3,000,000 acres, so that the scheme is capable of very great extension.

Some idea of the vast size of the irrigation works may be gathered by statistics given in the *Report*. The length of the Dam is 3,025 metres, or nearly two miles. The reservoir above the Dam will be a lake 50 miles long, with a capacity of 140,000 million gallons, i.e. enough water to supply the needs of Greater London for a period of nearly two years. The masonry of the Dam will weigh nearly 1,000,000 tons, while the weight of the ironwork will be about 3,300 tons. The canalised area for the first instalment is about the size of Bedfordshire, while the actual area under cotton will be half as large again as the County of London. The total length of canals is 3,697 miles and of field channels 5,589 miles, giving a total length of 9,286 miles. In May of this year 17,000 labourers were employed on the Dam and canalisation.

This great cotton-growing scheme, which will have such

an important influence on the future prosperity of the country, will be operated by the Sudan Plantations Syndicate, in co-partnership with the Sudan Government and the native cultivator. Already about one-fifth of the area to be cultivated by free flow water from the Dam is under cotton, which is being irrigated by water supplied from pumps. These various pumping stations have been started in order to accustom the native cultivator to growing cotton under conditions which will prevail when the Dam is completed. The quality and yield of cotton from these areas has been very satisfactory for a number of years past, and a particularly interesting feature of the work is that the bulk of the tenants have been drawn from the immediate neighbourhood.

The railway to Kassala was commenced with the object of developing cotton growing in the delta formed by the inland river Gash near the town of Kassala, but it should also lead to a general development of other products in the eastern Sudan, where development has hitherto been impossible owing to transport difficulties. The railway connects with the main Nile–Red Sea Railway near Haia, near Thamiam, about 124 miles from Port Sudan, and it is hoped that at some later date it may be possible to extend it to the southern districts of the Kassala Province to join up with the main line at Makwar, where it would cross the Nile by means of the Dam. The railway will be operated by the Sudan Government Railways Department under contract with the Kassala Railway Company, and will eventually become the property of the Sudan Government. The cotton-growing part of the scheme will be undertaken by the Kassala Cotton Company, which is closely allied to the Sudan Plantations Syndicate. A sharing system between the Company, the native cultivator and the Government, somewhat similar to that employed in the Gezira, is to be introduced.

As regards output of agricultural produce during the year, the quantity of cotton exported in 1923 was the largest on record, amounting to 248,365 bales (of 400 lb.) of lint, an increase of 3,816 bales over the figure for 1922 and nearly 9,000 bales more than the average for the years 1911–23. The value of the lint exported in 1923 was about £460,000. During the year 9,323 tons of cotton seed, valued at over £70,000, were also exported. The estimated area under cotton in the Sudan in 1923 amounted to 63,928 acres, made up of 6,381 acres of rain land, 26,016 acres under artificial irrigation and 31,531 acres of flood land. This area was much below that under cotton in 1922, the decrease being due to the rather

deficient Baraka flood at Tokar, the area flooded and cultivated being only 22,000 acres or half that flooded in the previous year. The following table shows the different areas under cotton in 1924 and their estimated yield.

Locality.	Type of Cotton.	Estimated Yield. Kantars.[1]
Sudan Plantations Syndicate :		
Zeidab	American	12,000
Barakat, Tayiba, Hosh and Wad el Nau	Sakel	60,000 to 65,000
Private :		
Various	American	3,600
	Sakel	1,400
Native :		
Tokar	Sakel	60,000 to 70,000,
Kassala	Sakel	15,000 to 20,000
Upper Nile	American	3,000
Gezira, Gedaref (rain grown)	American	5,000 to 6,000
Berber, Dongola (half Government, half Native) . .	American	12,000
Total (approximately) . .	Sakel	136,400 to 156,400
	American	35,600 to 36,600
		172,000 to 193,000

[1] 1 *Kantar = approximately* 100 *lb. of lint.*

The year 1923 was a phenomenal one for the Sudan gum industry. The record amount of 22,425 tons of gum was exported, an increase of 7,857 tons on the previous year's export. The chief purchasers were France (5,435 tons), Great Britain (5,227 tons), United States (4,735 tons), Germany (2,149 tons) and Italy (1,403 tons). The value of gum exported in 1923 amounted to £1,006,623, being more than 39 per cent. of the total value of the Sudan exports. By far the greater part of the gum exported comes from Kordofan Province, and it seems that the natives there are turning their attention to gum as a staple industry and regarding it less as a side issue. One reason for the record gum season was the high price that was maintained throughout the year, whilst the new auction system by which the Arabs are assured of getting good value for their gum and the fixed royalty rate which assists merchants to fix prices in making contracts were other contributory causes.

The yield of dura (*Sorghum vulgare*), which constitutes the main food supply of the country, was relatively low during the year. This crop fluctuates greatly from year to year, partly owing to its dependence on the rainfall, and also, to a considerable extent, according to the native cultivator's inclination to work. In 1920, 511,000 tons of

dura were produced, this very large crop being due to abundant rain and the necessity of making good a deficit in supplies resulting from two years of comparative scarcity. In 1921 cultivators had no inducement to sow the grain, as dura was plentiful and very cheap, and production therefore fell to 115,000 tons. In 1922, there was an increase to 217,000 tons, but this improvement could not be maintained last season owing to deficient rain and damage by pests, and only 142,000 tons were produced. The amount of dura exported in any particular year depends on the preceding year's crop. The season 1922-23 being a fairly good one, there was a considerable surplus available and 37,000 tons were exported. Of this quantity 13,500 tons went to Egypt, and 11,500 tons to Great Britain.

Sesame continues to be exported in fair quantity, mainly to Egypt, the exports during the year amounting to 10,402 tons. Small quantities went to Great Britain, Italy and France, but fiscal arrangements with Egypt tend to keep the price in the Sudan above the level at which large export to Europe is possible.

The so-called Alexandrian senna is a Sudan product obtained for the most part from uncultivated plants. The exports rose from 435 tons in 1922 to 833 tons in the following year.

The export of ground nuts, although growing, is still comparatively small, being 6,032 tons in 1923. To increase the trade it has been suggested that public auctions should be held in the chief centres in Kordofan Province. If the trade develops it is suggested that a decorticating plant might be provided, preferably at Khartoum.

There has been a considerable increase in the number of date palms planted in the Sudan during recent years and it is estimated that there are now over 1,250,000 mature trees in the country, mainly in Dongola, Halfa and Berber Provinces. The Sudan date is of the "dry" kind and unsuitable for export to Europe, but attention is being given to the possibility of growing a type of date suitable for export.

Date Growing in Mesopotamia and Egypt.—In this BULLETIN (1922, **20**, 325) an account was given of the cultivation of dates in Mesopotamia (Iraq), based mainly on two parts of a Memoir on *Dates and Date Cultivation of the Iraq*, by V. H. W. Dowson, issued by the Agricultural Directorate, Iraq. The third and concluding part of the Memoir, dealing with the varieties of date palms of the Shatt Al 'Arab, has now been published for the

Agricultural Directorate by W. Heffer & Sons, Ltd., Cambridge, price 10*s*. net.

The Shatt Al 'Arab date zone extends from Fao on the Persian Gulf to Qarna, a distance of 108 miles. It is partly in Persian territory and constitutes the largest single area devoted to the palm in the world. It has been computed that there are 15,000,000 palms in the Iraq portion of this zone alone, whilst the total number in the whole country probably approaches 30,000,000. With such vast numbers as these there is bound to be much variation. Altogether, one hundred and thirty-two varieties have been recorded from Iraq, of which Mr. Dowson tabulates 110, and describes in detail 48 occurring in the Shatt Al 'Arab. No attempt is made to classify the varieties, which in the present state of knowledge, and in view of the overlapping of forms owing to hybridisation, is practically impossible. Detailed measurements, such as were given by Mason in *Bulletin, No.* 223, 1915, *U.S. Dept. Agric.*, have been included in only a few instances, as it was considered that at present there is no better method than eye judgment. Consequently only general descriptive terms are used, such as long, medium and short, in describing the length of the frond, or many, medium and few in describing the spines.

Little appears to be known as to the origin of the date varieties in Iraq. There is a tradition in Basra that there was originally only one female variety, Zahidi, and one male variety, Khikri, and from these all others developed, presumably as seminal sports. But apart from the fact that these are the most widely distributed and that they are both inferior varieties, there seems to be nothing to support this theory. The process of formation of new varieties is still operating. If chance seedlings, due to promiscuous crossing, are allowed to grow, and if their dates are of good quality, their offshoots are planted out and the type is preserved. The ordinary name in Iraq for a seedling is Digal. If a seedling is worth propagating it is given a name to distinguish it from others, frequently the name of its first owner. Thus, for example, there are now recognised as distinct varieties Digal 'Abas, Digal 'Abd Al A'li and Digal Musa. In time, however, the prefix Digal tends to disappear. An old garden owner assured Mr. Dowson that in his childhood the Halawi (to which variety now belongs one palm in three on the Shatt Al 'Arab) was an uncommon variety, which had originated some time previously as a chance seedling. Appreciation of its value led to its rapid multiplication.

In the detailed description of each variety of female

date palm, a statement is given as to its distribution, yield, value, methods of cultivation and harvesting, and other general matters, and then follow descriptions of the palm and fruit. It is impossible here to deal with the different varieties, but it may be of interest to mention the characters which Mr. Dowson considers of importance in distinguishing the various kinds.

Although the yields of varieties differ widely, this character is dependent on so many factors and is especially liable to environmental influence, that, for purposes of classification, it is of little value. The rate of growth and vigour of the plant; the thickness of the trunk of the full-grown palm; the character of the old trunk, whether smooth or covered with old leaf-bases; the number and length of the fronds; the character and number of the spines on the basal part of the frond; the colour and size of the leaf-base; and the general habit of the fronds, whether erect, drooping, bunched, scattered, etc., are all useful diagnostic characters. The last-named feature is indeed so characteristic, that in many cases the Arabs, after sunset, can distinguish different varieties merely by their black silhouettes against the indigo sky.

The characters of the date fruit are more constant than those of the palm. Size is generally a useful distinguishing character, some fruits being nearly 2½ in. in length when well-grown, and others only ½ in. in length. Shape too differs between variety and variety, from almost spherical to very long and narrow. The colour varies in the different stages of development. The very young fruit is always green, but in the next stage (khalal) the colour is a constant character, and consequently of great value for purposes of classification. There is also a wide range in the flavour and the consistency of the flesh of the fruit.

Only a few varieties of male date palms have been recorded. This is doubtless due to the little attention that has been paid to the male palm and not to the intrinsically small number of varieties in existence. Since the palm is propagated by off-shoots, and seeds are not required by the grower, the nature of the male palm is not considered by the date grower, provided it supplies an abundance of pollen. Mr. Dowson mentions four of the more uncommon varieties which are said to produce a plentiful supply of fertile pollen, but each garden owner seems to have his own particular kind. The common male palm of the whole Shatt Al 'Arab region is the Khikri, a rankly growing, vigorous palm, easily distinguishable from surrounding females by its great height and girth,

larger number of fronds and more numerous and bigger spines.

Mr. Dowson includes in this part of his Memoir useful lists of the varieties of date palms recorded from other date-growing countries, with references to authorities on the subject.

An interesting description of the methods of cultivation of the date palm in Egypt and of the varieties met with in that country is given in "Date Palm in Egypt," by T. W. Brown, F.Z.S. (*Bulletin*, No. 43, 1924, *Technical and Scientific Service, Horticultural Section, Ministry of Agriculture, Egypt*). The conditions in Egypt approximate in many particulars to those in Mesopotamia and the methods of cultivation are very much the same in the two countries (cf. this BULLETIN, 1922, **20**, 325).

Propagation of the date palm is effected in Egypt as a rule by means of offshoots, but in Upper Egypt and Nubia the palm is occasionally propagated by seed, with the result that a large proportion of the fruit produced in those regions is of inferior quality. As in the case of Mesopotamia (see p. 349) a first-class date sometimes appears among seedling palms and this, when multiplied by offshoots, gives rise to a new variety. The palms as a rule are planted further apart in Egypt than in Mesopotamia, up to 35 ft. in the former as compared with 21 to 24 ft. in the latter country. Mr. Brown favours a distance of not less than 35 ft. between the trees, and points out that the roots of a full-grown palm are sometimes found over 20 ft. from the stem, whilst for a distance of 15 ft. the ground is usually full of roots. Planting takes place at almost any season of the year, that most favoured being the time of the high Nile (August and September), when the temperature is comparatively low, the atmosphere moist and water plentiful. The offshoots are commonly planted in their permanent quarters as soon as removed from the parent plant, but a better plan is to set them out in nurseries about 6 ft. apart, so that efficient watering, which is so essential to good results, may be more conveniently carried out.

Manuring the trees is much more common in Egypt than in Mesopotamia, pigeon manure, farmyard manure and night soil being frequently applied, either in holes a yard square on one side of the tree, in trenches, or spread over the ground. In some cases, vegetable marrows, tomatoes, etc., are grown between the palms and the latter benefit by the manure applied to such crops.

Pollination is carried out in much the same way as in

Mesopotamia, but the branches of the female inflorescence are sometimes loosely bound together with a palm leaflet, after the male flowers have been inserted in the bunch, to prevent the undue escape of pollen. The leaflet is sometimes tied in such a way that the bunch releases itself as it grows, or the tie is removed by hand, when the small unfertilised fruits begin to fall. As all the female bunches on a tree do not mature at the same time, it is customary to visit the trees two or three times in order to pollinate each bunch at the right time. Before the fruiting stems become hard the bunches are bent forward and tied to the mid-ribs of the leaves, in order to facilitate the gathering of the dates and to support the bunches when the fruit swells and becomes heavy.

Pruning of the leaves is almost universal in Egypt. As a rule the leaves are cut off when they are three years old, but the time and manner of cutting varies in different parts of the country and to some extent according to the variety of palm. The leaves are used for making bedsteads and crates for the transport of poultry and eggs, those from male and seedling trees being of greatest value for these purposes, the leaflets from such trees being employed for the better kinds of bags and mats. The leaves of the good fruit-bearing varieties are used for roofing houses and for fences.

Nearly 30 different varieties of Egyptian dates are described, five being "dry" dates, five "semi-dry" and the remainder "soft." The dry dates contain a high proportion of sugar and when dried by exposure to the sun may be kept for an indefinite length of time. Good varieties of dry dates are sweet and pleasing to the taste, but owing to their dryness are not looked on with favour by Europeans. When steeped in water, however, they become quite soft. The semi-dry dates are similar to the dry dates, but are softer and may be eaten with ease. In a dried state they may be packed loosely in boxes or sacks without fermentation taking place. The 'Amri dates, which belong to this class, form the greater part of the dates exported from Egypt to Europe. The soft dates contain a comparatively small proportion of sugar and are not easily dried by natural means. They are therefore eaten in a fresh state or made into 'agwa (pressed dates).

Mineral Deposits of Burma.—In *Records of the Geol. Survey of India* (1924, **56**, 65) J. Coggin Brown contributes a paper entitled "A Geographical Classification of the Mineral Deposits of Burma."

The author arranges the deposits in seven groups.

The first group comprises those of the Arakan-Naga region. This area is composed of much folded and altered strata of pre-Tertiary and perhaps mainly Mesozoic age, penetrated in many places by ultra-basic rocks, often altered to serpentine. Chromite, native copper, chalcocite, platinum, osmiridium, gold, chrysotile, steatite and magnesite are found in this region, but so far the deposits have not proved of economic importance.

The second group is in the Pegu Gulf area, which consists of Tertiary rocks ranging in complete sequence from Eocene to Pliocene. In this area are the important petroleum occurrences of Burma, considerable deposits of Tertiary coal in the Chindwin Valley and a small amount of amber.

The third group is in the Mogok-Frontier region, which is formed of gneiss and crystalline limestones. This region contains graphite deposits at Wabyudaung, Kyaukgyi and elsewhere, but they are apparently unimportant.

Ruby-bearing crystalline limestones are found in the Sagyin Hills and at Myitkyina, which formerly yielded rubies, sapphires and spinels. Low-grade quartz veins have been reported at Shweli River, Northern Shan States.

The fourth group is the Mingin. The deposits occur in a comparatively small area, characterised by quartz-diorites, intrusive into tuffs and other volcanic rocks. They are in the Mingin or Maingthong Hills in the Katha district of Upper Burma. The rocks carry gold-telluride quartz veins in which are also chalcopyrite, pyrite, galena, franklinite and altaite, a rare telluride of lead.

The fifth group is in the Chaung Magyi area, which is a region of mica-schists, slates, phyllites and quartzites intruded by dykes of tourmaline-granite and bosses of biotite-granite. Both series are traversed by quartz veins, usually barren, but occasionally carrying gold. Some alluvial gold has been won from stream gravels.

At Mong-Long tourmalines of gem quality have been obtained from gravelly detritus on hill slopes north of the Valley of Nampai, and are believed to have been derived from the weathering of the tourmaline-granite. Quartz veins in slates at Hungwe in Tawng Peng State are very pyritous.

The sixth group is that of the Shan-Yunnan region, which is composed chiefly of sedimentary rocks ranging in age from Ordovician to Jurassic. The deposits are sulphidic in character, and include the well-known and extensive argentiferous galena and blende deposit at Bawdwin, the less important deposits of lead-zinc ore at Mohochaung, lead-copper ore at Mong-Lung, argentiferous galena near Taunggaung, copper minerals near Maymyo,

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argentiferous lead and copper ores and pyrites at Bawzaing, pyrites and malachite at Kyauktat, argentiferous galena at Mount Pima, and also stibnite ores which have been referred to in this BULLETIN (1921, 19, 535). Other deposits of no great importance are galena in North-Eastern Putao, and galena and cupriferous pyrites of the Shweli-Nmai Hka divide in Myitkyina. Several of the above deposits have been worked, but at present only the Bawdwin deposit is being exploited.

The seventh group includes those deposits in the Tenasserim region commencing in the Mergui district in the extreme south of Burma and extending north through Tavoy, Amherst, Thaton, Papun and Karenni to the Southern Shan States.

A boss of biotite granite forms the cores of the ranges of the Indo-Malayan system, with which the wolframite and cassiterite veins of Burma are intimately associated. The predominating economic minerals of this region are wolframite and cassiterite, with smaller amounts of molybdenite, bismuthinite, native bismuth, chalcopyrite, pyrite, arsenopyrite, blende and stibnite.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.

AGRICULTURE

FOODSTUFFS

Tea.—The possibility of tea production in the West Indies is briefly discussed in *Trop. Agric. (West Ind.)* (1924, **1**, 102). A commercial experiment initiated in Jamaica about 1900 has proved a success, and the tea produced, which was first placed on the market in 1903, has been found to be of good quality for blending. In recent years labour costs have risen, and this has led to a certain amount of deterioration of the plantation. In general the cultivation of tea requires much more labour than that of sugar-cane, and in this respect is considered an expensive crop. It is thought, therefore, that tea culture in the West Indies

is unlikely to prove a commercial success, except in special circumstances, unless the cost of tea production in the East increases.

A comprehensive account of the production of tea in Japan appears in *Quarterly Journ. Scient. Dept. India Tea Assoc.*, 1924, Part I, pp. 1–46. Mr. C. R. Harler, one of the Department's chemists, visited the country in 1922, and made a tour of the tea districts, experimental stations and factories. All the tea is grown on the eastern or warm side of Japan, mainly in the Shizuoka prefecture, the city of that name being the business centre of the industry, while the district of second importance is Kyoto with the neighbouring prefectures of Shiga, Miye and Nara. About 37 million pounds, or about two-thirds of the total tea crop, is raised in Shizuoka, and is sold mostly as green tea. A trifling quantity of black tea is made, which is not a success, and it seems unlikely that the country will ever be a rival to India in regard to the tea industry. From 1915 to 1919 the area under tea remained steady at about 119,660 acres. A common size for a tea garden is a quarter of an acre, and is in striking contrast to the enormous size of tea estates in India. About 45 per cent. of the tea is kept for home consumption, and the remainder exported, chiefly to America and Canada, the total exports in 1912, 1918 and 1922 being approximately 35, 41 and 26 million pounds respectively. Shimizu is the premier tea port of the country, while Kobe has ceased to export tea and Yokohama exports only about 2 million pounds annually. The bushes, which are all of the China type, are not grown on the best land, but preferably on areas where rice and other crops cannot be raised. The gardens are generally hoed in April before the first plucking, and again in June and September, while trenching to a depth of two feet accompanied by burial of the summer weeds is often carried out in the autumn, and much use is made of mulching with straw or bamboo leaves. Practically the only manures used are those supplying nitrogen as their chief constituent, the principal being night soil and rape seed oil-cake. The first plucking, made in May, yields the best tea; the second is made about mid-June and the third in July or August. The last-named produces an inferior tea called Bancha. Compared with Indian standards the crop is large, as much as 16,000 lb. of green leaf per acre, yielding somewhat less than 4,000 lb. of tea, having been obtained under exceptional conditions in Shizuoka. It is a common practice to roll the leaf by machine till it has a moisture content of about 50 per cent., and to complete the later stages

of rolling by hand. The account describes the methods of cultivation and the manufacturing processes in detail and contains much information regarding the composition of the leaf.

Rice.—The nutritive properties of wild rice (*Zizania aquatica*) have been investigated at the Minnesota Agricultural Experiment Station and the results are recorded in *Journ. Agric. Res.* (1924, **27**, 219). Wild rice was found to have a greater food value than the polished cultivated rice with which it was compared, because its proteins are in larger amount and of better quality, and because it contains adequate amounts of vitamin B for animal growth, which is not true of the polished cultivated rice. Like the latter, it is not an adequate food and is stated to be very deficient in vitamin A.

Sugar Cane.—With a view to establishing new industries in Palestine, attention has been given to the production of sugar by the Agricultural Experiment Station of the Institute of Agriculture and Natural History (Zionist Organisation), and the results of the work have been issued by the Station in *Bulletin* No. 3, entitled "Preliminary Report on the Agricultural Aspects of a Sugar Industry in Palestine" (1924). Sugar cane is already grown in the country and the canes are sold in the markets for chewing. Its place is but incidental in the rotation of crops, and only a small area is devoted to it. The present annual importation of sugar into Palestine amounts to about 8,000 tons, but it is considered that the consumption is likely to increase rapidly in the future. The preliminary experiments which have been conducted were subject to defective irrigation, and the value of the results was therefore diminished. From 45 to 100 tons of cane per hectare were obtained, the sugar content ranging from 9 to 18 per cent. Further experiments on a larger and more satisfactory scale are necessary to admit of definite conclusions being drawn, but it is considered that high yields of cane could be obtained under proper cultivation. Difficulties would be encountered with regard to labour, wages in Palestine being higher than in Egypt and other cane-producing countries, and the fact that the industry requires seasonal workers is regarded as an unfavourable feature. On the other hand, the value of land and the cost of irrigation would be much less than in Egypt. It is suggested that the industry might be established on a system of small holdings, thus eliminating expensive hired labour; and further, it is proposed to explore the possibility of extending the harvesting

period, and consequently the manufacturing period also, and the possibility of combined cane and beet sugar production in two different seasons.

RUBBER

Hevea

Rubber from Maltreated Trees.—An interesting series of experiments on the effect on the quality of the rubber of maltreating the Hevea tree is described by Dr. O. de Vries in the *Archief v. de Rubbercultuur* (November, 1923, p. 492). Dr. de Vries has already shown in previous papers that neglect of soil upkeep, tapping to the wood and pollarding the trees have little effect on the vulcanising properties of the rubber. He now goes on to show that if the trees are still further mutilated by cutting away the whole of the crown and most of the roots, and if the stem and 3 ft. of the tap root and 1 ft. of the principal lateral roots are then transplanted, the vulcanising properties of the rubber obtained on the resumption of tapping appear on the whole to be normal.

Rubber from Buddings.—It is well known that rubber obtained from individual trees varies considerably in its vulcanising properties even when prepared by a strictly standardised process. It is of importance, therefore, to study the variability of rubber from individual buddings from one mother tree to discover whether the results are more uniform than the rubber from seedlings. Such investigations have been made by Dr. O. de Vries and details of his results may be found in the *Archief v. de Rubbercultuur* (March, 1924, p. 111).

The first experiments were made three years after budding and a further series when the trees were five or six years old, and comparisons were made with seedlings of a similar age all from one mother tree. The variation in the rate of vulcanisation was two to three times as great in the case of the rubber from the seedlings as in that from the buddings.

Djambi Rubber Tapping.—An account of native rubber production in the Djambi district of Sumatra, taken from a letter written by Dr. R. Broersma to the *Nieuwe Rotterdamsche Courant*, is given in the *Netherlands Indies Review* (June, 1924, p. 15).

The number of trees in this district is said to be over 17 million, and according to Dr. Broersma 17,389,229 kilos of rubber have been exported. It is expected that for some little time to come the exports of rubber will increase.

The trees are intensively tapped. Old tins and cups are used to collect the latex, which is coagulated by means of alum. From the coagulum, thick cubes are made of a slovenly shape and with an indescribably bad smell. The cakes are bound together in bundles of four, hung on a bamboo raft and thus trailing in the water are taken to the place where they are sold to the Chinese buyer. They are then sent to Singapore and manufactured into crêpe.

FIBRES

Cotton

Uganda.—In the *Uganda Official Gazette* of April 15, 1924, an outline is given of the Government's policy for the better control and development of the cotton industry of the Protectorate. In general, free competition will be permitted in the purchase of seed-cotton, and the Government will not intervene in regulating prices. Close Government control of the industry will be maintained, however, in the interests of all concerned. In order to relieve the Director of Agriculture in his heavy responsibilities, a Cotton Control Board is to be set up, the functions of which will include the selection of central markets and the consideration of applications for the erection of ginneries; moreover, the Board will act generally in an advisory capacity to the Governor in all matters connected with the cotton industry.

It is considered that the existing tax of 6 cents per lb. of lint does not press heavily on the industry under prevailing prices, but the matter will be reconsidered if prices fall to any great extent.

The grading of seed-cotton is not to be made compulsory, but the native growers will be strongly advised to practise it. A standard scale is to be prescribed with the object of giving the grower the opportunity of observing for himself the registered weight of his cotton, and a Government standard scale will be placed at each central market. A new cotton rule will be framed so as to prohibit, during the course of the day, the lowering of a buying price once marked up on a buyer's board, the object being to prohibit the publication of temporarily inflated prices intended to attract sellers of cotton.

The Government will continue to requisition cotton seed free of cost for distribution to planters, but care will be taken that notice of the requirements is given well in advance and that, so far as possible, a proportionate amount of seed is taken from each ginnery in the specified area. As it is imperative that the crop should be grown

from seed approved by the Director of Agriculture, it is intended to prohibit the sale of seed for planting purposes.

In order to prevent bribery and abuses, the following existing rule is to be stringently enforced: "No contract for the purchase of raw cotton shall be entered into the consideration for which is to be paid other than in cash and no financial inducement shall be offered to the vendor by the purchaser or by any other person to enter into any contract for the sale of raw cotton." The object of this rule is to prevent forward contracts, to ensure that all transactions shall be conducted on a strictly cash basis, as opposed to barter, and to prohibit any extra inducement, financial or otherwise, being offered to the vendor as a consideration for the sale of his cotton.

The practice adopted in the Eastern Province of concentrating buying at ginneries and central markets will be extended to the whole Protectorate as soon as possible. The extension of the central market system will be one of the first matters for attention by the new Cotton Control Board.

The Government consider that any limitation of the market for Uganda cotton, by direct or indirect action on their part, is neither desirable nor possible.

In an address delivered by the Governor of Uganda to the Legislative Council on May 28, 1924, which has been printed in the *Official Gazette of the Uganda Protectorate* of May 31, some interesting observations were made on the subject of the cotton industry. It was pointed out that the outstanding feature of Uganda to-day is the success of this industry, the intense interest that is being everywhere displayed in its development, and its great potentialities, and that in this connection great credit is due to the Agricultural Department.

Last season's crop amounted to about 93,000 bales (of 400 lb.) of ginned cotton, whilst this season the output will exceed 125,000 bales, an increase of 34·4 per cent. The value of this crop to the native cultivators is computed to be between 2½ and 3 million pounds sterling.

During the present season the Mengo district of Buganda has produced 30,000 bales and the Busoga district 25,800 bales; the average return per taxpayer on his cotton plot is over £10 in the former district and over £9 in the latter. The production in Busoga per taxpayer (of whom there are 57,000) is 632 lb. of seed-cotton, whilst in Mengo the output is no less than 706 lb. per taxpayer. For the whole of the Eastern Province the average area under cotton per taxpayer is now 1·21 acres and the average return to the

grower is over £6. Of the total sum paid for the Uganda crop, about £1,500,000 is paid to the natives of the Eastern Province.

The Governor expressed his personal opinion that, in view of the prevailing enthusiasm and the higher yield per acre (averaging 532 lb. as compared with 355 lb.), production in Buganda will shortly rival that of the Eastern Province. Other promising fields for development are Bunyoro, Gulu and the banks of the White Nile. It is considered that with the extension of ploughing and other labour-saving devices, and with the maintenance of reasonable prices, the production will shortly amount to 250,000 bales. The Empire Cotton Growing Corporation has presented 300 ploughs for demonstration purposes in new districts, and these are in great demand.

The Government of the Protectorate is fully alive to the obligations of the industry, and there is no doubt that valuable service will be rendered by the newly appointed Cotton Control Board. Every effort is being made to keep pace with the increasing production by developing communications and mechanical transport. The construction of metalled roads in the Eastern Province at the end of last year under the communal labour system was a great success, and further progress is being made this year in the same direction. Road-making is also being pushed forward in Buganda. It is contemplated that the extension of the main line of railway to Uganda will be commenced next January, working from both the Busoga and Turbo ends. A recent development has been the transfer to the Uganda Railway of the Lake Albert Marine and the Butiaba-Port Masindi motor service, and through rates for this section have been accorded, to the great advantage of the European planter in Bunyoro and to the benefit of local native production and the Congo trade. Similarly, it is proposed to bring Toro within the service of the Uganda Railway by the early construction of a cart-road from Fort Portal to Ntoroko at the southern end of Lake Albert. A light railway will shortly be required to deal with the traffic passing over the Butiaba-Port Masindi stage.

The labour question is still a difficulty, and the policy of the Government is to encourage the free flow of labour to productive areas from the outlying districts of small economic importance.

India.—In the Central Provinces and Berar, the cotton crop is seriously affected by wilt, which has now spread to such an alarming extent that the Indian Central Cotton

Committee have authorised an experimental study of the disease both in these Provinces and also in Bombay.

A paper, entitled "A Preliminary Account of the Investigation of Cotton Wilt in Central Provinces and Berar," by J. F. Dastur, M.Sc., D.I.C., officiating mycologist to the Government of the Central Provinces, was read at the Indian Science Congress, Bangalore, 1924, and has been printed in *Agric. Journ. India* (1924, **19**, 251). After reviewing the earlier work on the subject, the author expresses the opinion that the conclusion arrived at by Butler (*Rep. Agric. Res. Inst., Pusa*, 1913–14, 55) and by Ajrekar and Bal (*Agric. Journ. India*, 1921, **16**, 598), attributing the disease to a species of *Fusarium*, is not justified, and that satisfactory evidence has not yet been produced to establish the view that the wilt is caused by any fungus.

In a series of experiments recently carried out, it was found that the tissues of wilting cotton plants always contain an accumulation of iron and aluminium compounds which are invariably absent from healthy plants. In certain tests made with cotton plants attacked by *Rhizoctonia solani*, Kunz, the results showed that in this case the tissues were free from any accumulations of iron and aluminium salts and that these compounds are peculiar to plants suffering from wilt. It therefore appears probable that the presence of the iron and aluminium compounds may have some correlation with the wilt, and that the species of *Fusarium* which has been isolated from wilting plants in different cotton tracts may be merely a contributory factor in hastening the death of the plant, the fungus not appearing in the tissues until after the iron and aluminium compounds have accumulated.

Queensland.—It has recently been established that the pink boll-worm (*Gelechia gossypiella*) is present in Queensland. So far it has only been found in the coastal areas, with the exception of one or two places, such as Baralaba.

In view of the danger arising to the growing cotton crop, an Order in Council was made on May 8, 1924, proclaiming the pink boll-worm a pest in any district in Queensland and enacting that on or before June 30, 1924, every grower must destroy all ratoon and stand-over cotton plants on land under his control. It was arranged that compensation for ratoon bolls or stand-over bolls, immature or unmarketable on June 16, should be paid on the basis of the difference between the net amount received by the grower for ratoon cotton and stand-over cotton harvested and disposed of before that date and a fair estimate of the

net amount which such grower would have received for his crop if he had been allowed to continue the harvesting until July 31. It was further ordered that every grower having ratoon or stand-over cotton under his control should make a declaration giving particulars of his total cotton area and that under ratoon or stand-over cotton; the quantity of ratoon and stand-over cotton harvested during the current season and the estimated weight of such cotton remaining unharvested; and certain other information. Any person committing a breach of the provisions of this Order was to be regarded as guilty of an offence and liable to a penalty of £100.

It is stated in the *Queensland Agric. Journ.* (1924, **22**, Part I, 31) by the Cotton Entomologist that in order to control the pest all seed for sowing is being treated in a Simon's heater to destroy hibernating larvæ, and that any larvæ which may be lying in wool packs are also being destroyed by heat so that packs from an infested area may be sent to a non-infested area without risk. It is added that other control measures must be applied by the farmer by cleaning up his fields thoroughly after harvesting his crop and destroying all plants and refuse, especially old bolls, by fire.

It has been pointed out by the Minister for Agriculture and Stock, in a statement issued to the press, that the prohibition of the cultivation of cotton as a ratoon crop is warranted by the following facts. On the occasion of the visit of the British Cotton Delegation in 1920, the Government was strongly advised not to permit ratoon cotton to be grown under any conditions. In support of their arguments, the Delegation had pointed to the legislation that had been passed in other parts of the world, and declared emphatically that ratoon lint was, generally speaking, inferior to that of annual cotton. They declared, amongst other things, that the ratoon lint was inferior in character in regard to strength, length and uniformity of staple, and in nearly every case it was found to be shorter, weaker, harsher, lighter of body and lacking in twist. They also stated that the percentage of lint to seed was much lower in the case of ratoon, and that the cost of picking was generally greater. The Delegation also gave a warning regarding the greater danger involved in growing ratoon in connection with the spread of pests and diseases, owing to the roots remaining in the ground providing a continuous harbourage for such pests.

The Order prohibiting the growing of ratoon cotton has aroused considerable opposition among the cotton farmers, and the Queensland Cotton Growers' Union have

formed a Ratoon Cotton Defence Committee, whose views have been put forward in the pages of the *Cotton Farmer and Dairyman*, the organ of the Union. It is suggested that the opinion expressed by the British Cotton Delegation as to the inferiority of ratoon cotton was based on a misapprehension, the term "ratoon cotton" being confused by them with "bolly cotton," i.e. the last cotton pickings of the season consisting of immature cotton from bolls which have not opened completely or have not fully ripened. It is asserted that experience and observation of ratooned and perennial cottons have proved that when a suitable growth has been obtained the quality of the fibre does not deteriorate but remains practically fixed throughout the plant's life. With regard to yield, the present season has fully demonstrated that ratoon cotton shows a great advantage over annual cotton. In respect of the question of insect pests, it is stated that in growing cotton as ratoon or perennial, the plants are spaced much more widely than in the case of annual cotton, and that consequently the fields are more easily cleaned and the plants are obviously more exposed to sunshine and to birds and parasitic enemies of the cotton pests. In any case, cotton grown in that way is much less liable to insect attack than cotton planted closely as an annual. The Ratoon Defence Committee also express the view that cotton cannot be grown remuneratively in Queensland as an annual, and it is stated that the present drastic legislation has forced experienced growers to declare that after the harvesting of the present crop they intend to abandon cotton growing. In connection with this question, the cotton farmers of Central Queensland have commissioned Mr. Daniel Jones, who was at one time an officer of the Queensland Department of Agriculture and has had an extensive experience of cotton growing in the State, to visit Great Britain on their behalf. Mr. Jones has arrived in England and is making investigations, particularly in Lancashire and Yorkshire, regarding the relative market values of ratoon and annual lint.

Gums and Resins

Lac.—A translation by Syed Mahdihassan of M. Leon Hautefeuille's *Report on Lac and its Industrial Treatment* is given in *Bulletin* No. 2, 1924, *Dept. of Industries and Commerce, Hyderabad*. This investigation was undertaken chiefly with a view to the improvement in quality, increase in output, and correction of errors in the manufacture of the lac produced in Indo-China, and was conducted in 1913–14 on behalf of the Government of that country.

About sixty host plants are mentioned on which the lac insect (*Tachardia lacca*) has been found to live. The methods of pruning and inoculating the principal trees and the collection of the stick-lac are similar to those employed in India and described by Misra in *The Cultivation of Lac in the Plains of India*, published in 1912. This useful brochure, which has been recently revised in *Bulletin* No. 142, 1923, *Agric. Res. Inst., Pusa*, is quoted extensively throughout the present publication. Although, as in India, two crops are usually obtained during the year, at several centres, owing to the relative severity of the winter, one crop only can be collected. Indo-Chinese stick-lac is deeper in colour than the Indian variety; the layer is, however, thicker, harder and not so brittle as Indian stick-lac, and is more readily removed from the twigs. The lac is refined according to the general method employed in India. In a detailed account of the process, reference is made to the small percentage of rosin which in India is usually added in order to lower the melting-point of the lac and thus facilitate the preparation. Owing to its rather different physical properties, the grinding and sifting of Indo-Chinese lac present fewer difficulties, and refining can be carried out without the addition of rosin, which is only employed in the treatment of poorer residual products. It is stated, moreover, that no orpiment is used in the manufacture of shellac in Indo-China. In India about 2 or 3 per cent. of this mineral is commonly added to the seed-lac to improve or disguise the colour of the shellac, rendering it more opaque and apparently paler in colour.

An interesting account is given by M. Hautefeuille of three tours undertaken with a view to obtaining definite information as to the distribution and production of lac in Indo-China. *T. lacca* is found throughout Indo-China wherever favourable conditions obtain, but the principal regions were shown to be Sonla, the Song Ma and the Nam-How. Although requiring an airy locality, the lac insect is injured by strong winds and rain, and is also damaged by excessive heat and prolonged drought, and it was discovered that it did not thrive below 1,300 ft. or above 2,200 ft. M. Hautefeuille concludes his report by summarising various problems in connection with the production of lac in Indo-China, upon the solution of which he considers the successful development of the industry is largely dependent.

The export of lac and stick-lac from Indo-China in 1913 was 794·41 tons, whereas more than double this quantity, namely 1,845·67 tons, was exported in 1923.

Tanning Materials

Wattle Bark.—A note by Welch, McGlynn and Coombs on the nature and distribution of the tannins in Australian wattle barks, and on the bark anatomy, with microphotographs, appears in *Proc. Roy. Soc. New South Wales* (1924, **57**, 313). It was shown that the tannin is found principally in the outer parenchymatous cells of the medullary rays, in the primary and secondary cortex, and also in the phloem parenchyma. The degree of development of the bast fibres, which have a relatively high specific gravity and contain no tannin, has an important bearing on the tanning value of the bark. Under normal conditions the amount of tannin in the bark is proportional to the age of the tree. Old trees, however, do not necessarily contain more tannin than young trees, for the amount of fibre present is an important factor, and the thickness of the bark is usually more important than age in its influence on the tannin content. Experiments showed that the amount of tannin was highest in the bark near the base of the tree. The authors have not obtained any direct evidence that the percentage of tannin in wattle bark varies at different times of the year, and recommend that the bark be stripped in the spring when the operation can be carried out more readily. Experiments afforded no evidence to support the prevalent idea that the solubility of the tannin increases with the length of time the bark is kept after stripping.

Myrobalans.—The results of an examination at the Imperial Institute of thirty-seven samples of myrobalans from different parts of India and Burma have been given in this Bulletin (1924, **22**, 123). A report by Pilgrim on the analysis of fifteen of these samples has now appeared in *Indian Forest Bulletin*, No. 56, 1923, and shows results in the main similar to those obtained at the Institute. A marked discrepancy occurs, however, between the figures obtained for samples Nos. 11 and 26, especially in the case of the latter sample, where the tannin content shown in the Imperial Institute analysis is very much higher than that recorded by Pilgrim. From a study of the figures given below it seems possible that Nos. 11 and 26 in Pilgrim's set of samples may in some way have been reversed, and this is supported by the fact that the five different samples of fruits from the Salem Division, Madras, examined at the Imperial Institute all showed considerably higher percentages of tannin than that recorded by Pilgrim in the case of No. 26.

Sample.	Label.	Tannin per cent. calculated on moisture-free material. Analysis by	
		Imperial Institute.	Pilgrim.
11	*T. chebula*, Betul Div., Central Provinces.	37·8	46·1
26	" " East Salem Div., Madras	49·2	37·7
25	" " " " "	46·0	44·9
24	" " South " "	52·6	Not examined
23	" " " " "	52·2	"
22	" " North " "	54·4	"

Miscellaneous.—Pilgrim (*loc. cit.*) has also determined the amount of tannin in the leaves, bark and wood of different species of Burmese *Terminalia* when not in fruit, and has obtained the following results which are calculated on the moisture-free material:

—	Sample from	Tannins.	Soluble Non-tannins.
T. Bellerica:		*Per cent.*	*Per cent.*
Bole bark	5 trees	3·8	12·6
T. chebula:			
Leaves	11 "	17·4	11·6
Twig bark	11 "	18·4	8·9
Bole " (inner portion)	12 "	16·0	7·1
" " (cortex)	12 "	8·5	3·9
Wood	6 "	5·0	2·6
T. bialata:			
Leaves	5 "	10·1	20·3
Twig bark	5 "	13·9	13·7
Bole " (inner portion)	6 "	25·2	14·6
Wood	5 "	2·4	5·9
T. tomentosa:			
Leaves	10 "	15·4	16·2
Twig bark	10 "	10·0	7·1
Bole " inner portion)	12 "	14·1	5·1
Wood	6 "	2·3	1·7
T. Oliveri:			
Leaves	12 "	16·9	21·1
Twig bark	12 "	21·6	14·5
Bole "	12 "	23·0	14·3
Wood	6 "	3·2	2·8

Most of these materials produced rather dark-coloured extracts, and none were sufficiently rich in tannin to be worth exporting. It will be seen, however, that many of them contain a high proportion of tannins to soluble non-tannins and would thus be suitable for the manufacture of tannin extract. The actual tanning properties of these materials were not determined.

Bulletin No. 57 of the same series contains the results of an examination by Pilgrim of the bark of two other Burmese plants. That of *Pinus Khasya*, although furnishing a slow

tannage, produced orange-brown-coloured leather of great strength and altogether of very satisfactory quality. The extract from this bark was recommended as a valuable tanning material for medium and heavy leathers. *Xylia dolabriformis* bark contained a large proportion of soluble non-tannins and thus would be only of local value. The analytical figures calculated on the moisture-free material were as follows :

—	Sample from	Tannins.	Soluble Non-tannins.
Pinus Khasya :		*Per cent.*	*Per cent.*
Bark in autumn	12 trees	6·7	2·8*
„ „ spring	Not stated	10·2	4·8
Xylia dolabriformis :			
Twig bark	7 trees	8·7	11·6
Bole „ (whole)	12 „	11·8	13·6
Wood (average)	6 „	4·3	1·9

A further tannin investigation by Pilgrim of some Burmese Dipterocarps appears in *Indian Forest Records* (1924, **10**, 167). The analytical results are summarised in the following table:

Sample from	Material.	Tannins on moisture-free material.	Soluble Non-tannins on moisture-free material.
	Hopea odorata :	*Per cent.*	*Per cent.*
6 trees	Leaves	10·9	12·4
6 „	Bole bark (inner portion)	13·7	6·4
6 „	Cortex of bark	14·6	3·1
4 „	Average wood	10·3	2·5
	[1]*Pentacme suavis :*		
6 „	Young red leaves	23·5	22·4
10 „	Green leaves	12·4	23·0
10 „	Bole bark (inner portion)	13·1	10·4
10 „	Cortex of bark	7·3	3·9
6 „	Average bole wood	4·2	2·5
	Shorea obtusa :		
12 „	Twig bark	9·1	7·3
12 „	Bole bark (inner portion)	9·0	9·2
12 „	Cortex of bark	9·2	4·4
6 „	Average branch wood	6·5	3·8
7 „	Average bole wood	6·0	2·2

[1] *According to Index Kewensis, P. suavis = Shorea siamensis.*

The above analyses show that concentrated tannin extracts could be obtained in most cases from the bark and wood of these species. Both the inner bole bark and the cortex of *Hopea odorata* produced similar supple, very

pale-coloured leathers of excellent quality, and hence it would be best to employ the whole bark. The tannage with the wood of this tree was fairly rapid, and a particularly strong leather was obtained possessing distinctly sole leather characteristics, except that it was practically white. The author states he had found nothing equal to it of its kind in the whole of India. The analytical results for the other two species are not so satisfactory. *Shorea siamensis* (*Pentacme suavis*) bark leather was reddish-buff in colour, tough, and of fairly satisfactory quality. *Shorea obtusa* bark gave a somewhat paler leather, strong and supple, with rather drawn grain. The wood of these last two species produced buff-coloured leathers, similar in character and of useful quality. Different parts of the trees of *Dipterocarpus turbinatus* and *D. alatus* were also examined for tannin, but yielded disappointing results.

MINERALS

Barytes

Ireland.—In the series of *Memoirs of the Geological Survey of Ireland on Mineral Resources*, a memoir has been published on Barytes by T. Hallissy (Dublin : Stationery Office, 1923). There are considerable deposits of barytes in the island, but largely owing to insufficient financial resources the industry has had a chequered career. The first production, recorded in 1854, was 2,580 tons, the maximum was 17,937 tons in 1915, and in 1919, 5,096 tons were raised. Almost all the workable deposits are of the vein type, barytes sometimes forming the mass of the deposit, but generally acting as the gangue of metallic ores. The principal veins are in the Cork and Bantry districts, where they are confined to a narrow belt at the top of the Old Red Sandstone series (the Yellow Sandstone or Kiltorcan Beds), and in the Sligo district where the veins are found in the Upper Carboniferous Limestone. There are minor occurrences in Antrim, Armagh, Cavan, Clare, Cork, Donegal, Down, Dublin, Galway, Kildare, Leitrim, Limerick, Londonderry, Louth, Monaghan, Queen's Co., Tipperary, Tyrone, Waterford, Westmeath, Wexford and Wicklow. The author is of the opinion that all of these are of contemporaneous origin, having been accumulated some time between the period of erosion of the Upper Chalk and the outpouring of the Tertiary lavas.

The *Memoir* contains detailed information regarding these occurrences, and concludes with some remarks on the industrial applications of barytes.

Coal

Canada.—The geology along the Blackstone, Brazeau and Pembina rivers in the Foothills Belt, Alberta, is described by John A. Allan and Ralph L. Rutherford (*Province of Alberta Scientific and Industrial Research Council Report* No. 9, 1924). The area described is 65 miles long and 25 miles wide. The Kootenay formation in which the Lower Cretaceous coal of Alberta occurs is referred to in the Imperial Institute Monograph, *Coal* (1920, p. 97). In the present report the Kootenay strata have been divided into two members, namely, the coal-bearing member below and the McLeod member above. The Kootenay strata in this map-area consist of alternating beds of conglomerates, sandstones, clay-shales, carbonaceous shales and coal seams. In the Bighorn Basin the Kootenay has a measured thickness of 3,600 ft., but it is probably somewhat thinner in this map-area. It is of continental or freshwater deposition. The coal seams at Nordegg, Bighorn Basin, are being mined by the Brazeau Collieries. Coal seams in the vicinity of Medicine Lake, west of the Bighorn Range, can be mined more economically than those on the main Brazeau or on the North Brazeau, as they occur on high ground. Considerable prospecting and drilling has been done by the British Collieries in township 43, range 20, near the main Brazeau. The coal seams at this locality are presumably the northern extension of those exposed in the Bighorn Basin.

The lower member of the Saunders formation of the Montana group of the Upper Cretaceous also carries coal seams. This member is also of continental or freshwater deposition, and is separated from the Kootenay by the Colorado group consisting of dark marine shales. The Kootenay and Saunders coal-bearing beds are separated by at least 3,000 ft. of strata. In the Saunders field there are five coal horizons, separated by sediments, 1,000 to 5,000 ft. in thickness. The No. 4 coal horizon is mined at Saunders Creek, east of Nordegg, and the No. 3 (which is 2,000 ft. below No. 4) is mined extensively to the north of Brazeau River by the numerous mines along the Alberta Coal Branch of the Canadian National Railway. The seams mined are on the average much thicker than any exposed on the Brazeau River. Saunders coal is sub-bituminous. The Val d'Or seam of the Foothills Collieries (Alberta Coal Branch) consists of 5¾ ft. of coal with a 4-in. clay parting near the centre (known as No. 1 seam), and 8½ ft. lower down of 9¼ ft. of coal, with a 12-in. clay and hard shale parting (known as No. 2 seam). Most of the mining done has been in this seam.

The new copper district near Salmon, Lemhi Co., Idaho, is described by Clyde P. Ross (*Eng. and Min. Journ.-Press*, August 9, 1924, p. 205).

All the copper deposits examined by Ross are shear zones in quartzitic rocks of Algonkian (pre-Cambrian) age, and are formed largely by replacement, although there has also been some fissure-filling. The minerals of the lodes comprise quartz, various micas, chlorite, epidote, chalcopyrite, magnetite, specularite, blende (scarce), secondary chalcocite, primary bornite (generally rare), delafossite ($Cu_2O.Fe_2O_3$) and barytes. The last two were noted in one mine only. The lodes are roughly tabular masses of sheared and somewhat altered country-rock, striking N.W., from a few inches to 20 ft. or more in width. In all the ore-shoots there are slabs (horses) of almost barren rock intercalated in the ore. As many as six lodes have been recognised in an area 6,500 ft. long by 1,500 ft. wide. The shoots are roughly lenticular in shape, averaging about 10 ft. wide, a few hundred feet in length, and probably extending to at least 300 ft. in vertical depth. There appears to be genetic relation between the ore deposits and the batholithic intrusions and structural disturbance which took place at the end of the Mesozoic period.

The average ore mined carries 2½ to 6 per cent. of copper, and a very little gold and silver. From 1911 to 1922, inclusive, about 20,000 long tons of copper ore, containing 752 tons of copper, 1,028 oz. of gold and 7,546 oz. of silver were shipped from Lemhi Co. At present two mines are shipping concentrate steadily, and two other properties are being developed."

Gold

Canada.—The Rowyn-Boischatel gold area, Timiskaming Co., Quebec, is briefly described by R. E. Hore (*Canadian Min. Journ.*, August 1, 1924, p. 745). At the Horne mine about 40 diamond drill holes have been bored and shaft sinking is in preparation. A very large deposit of copper-gold ore has been found here. The country-rock is described as a fragmental siliceous lava, and the ore is a mixture of chalcopyrite, pyrrhotite and pyrite. The gold content of parts of the deposit is fairly high and most of the ore contains at least appreciable quantities of gold. At the Chadbourne, exploration is being carried on from a shaft, which is about 150 ft. deep, in brecciated, pyritic, grey volcanic rocks. At the surface many channel samples gave good gold contents. Prospecting is being carried on in the Lake Fortune and numerous other properties in Boischatel and Rowyn townships.

The Chadbourne and Horne properties have already been dealt with by Dr. Cooke (see this BULLETIN, 1924, 22, 88), according to whom, the country-rock is rhyolite, cut by numerous irregularly shaped masses of fine-grained gabbro.

United States.—The ore deposits of the Manhattan district, Nevada, are described by Henry G. Ferguson (*U.S. Geol. Survey, Bulletin* 723, 1924). The mines of Gold Hill have yielded the largest production in the Manhattan district. The Gold Hill formation consists of a series of schistose slate, quartzite and sandstone. A short distance above the lowest member of the formation is a group of three limestone beds. The most interesting ore deposits of the district are confined almost entirely to the highest of these beds, which is 30 ft. thick, and known as the "White Caps limestone," but the ores show great variation in character along the bed. The productive zone is less than two miles in length. Throughout its course the limestone is broken by closely-spaced normal faults, mostly of small throw, and striking a few degrees east of north. The portions of the rock cut up by faults are known as "limestone blocks." There are later faults of flatter dip, striking N.E., which show greater displacement. Both series of faults cut an older fault known as the "overthrust fault." In addition to these are some obscure faults of another type, by which the limestone bed is repeated in several of the mines.

In the White Caps mine, the ore occurs in large bodies, replacing the limestone. The mineralisation usually follows the foot-wall. The rock in which the small faults are most numerous appears to be the most highly mineralised. The principal sulphides are pyrite, stibnite, realgar, orpiment, and probably arsenopyrite. Cinnabar was found in ore above the 200-ft. level, and in 1923 was found in appreciable amount in the 980-ft. level. The realgar and orpiment are auriferous, but the stibnite is practicably barren. The gangue minerals are calcite, quartz and less commonly dolomite, fluorspar, sericite and leverrierite (a hydrous aluminium silicate). Near the outer edges of the ore-bodies, barren white calcite has replaced the limestone. The best ore of the mine consists of a dark fine-grained quartz containing minute specks of pyrite. Under the microscope the dark colour is seen to be due to disc-like specks of carbonaceous matter, and to minute crystals, which may be arsenopyrite or stibnite, or both. The quartz has replaced the limestone, and, to a less extent, the coarse calcite. No free gold has been found in the White Caps mine. The bullion (from the cyanide process) contains little silver—the ratio of gold to silver being about 17 to 1.

Brazil.—In an interesting account of exploration in Central Brazil, Stanley C. Bullock (*Mining Mag.*, **31**, 1924, pp. 9 and 73) describes a gold deposit at Chapeo do Sol, near Crixas, Matto Grosso, which is being developed by an English company.

The country-rock is mainly schist, covered in most places by *canga* (a porous ferruginous conglomerate). Granite, gneiss, sandstone and diorite are also found in the area. The ore-body, below the old workings, consists of about 20 ft. of talcose schist with bands of white quartz, the gold content of which varies considerably, but probably averages 5 to 6 dwt. per ton. Above the schist is a layer of blue quartzite, 10 ft. thick, which carries 5 to 10 per cent. of arsenopyrite, and, occasionally, blende. The whole layer assays 8 to 9 dwt. of gold per ton. Below the schist is hard quartz with patches of galena and traces of chalcopyrite. The quartzite appears to form the top of an anticlinal fold, but sufficient work has not yet been done to prove the true value or character of the ore-body, which, so far, has been exposed for a length of 500 ft.

Iron

India.—In *Rec. Geol. Surv. India* (1923, **54**, 431) E. L. G. Clegg describes two iron-ore deposits found in the Northern Shan States, which have been worked by the Burma Corporation to obtain iron ore for use as a flux in lead smelting.

One deposit is at Kunghka Village, 17 miles from Nam Tu, where the Corporation's smelters are erected. It occurs in the Pang Yun Series of rocks, which is believed to be of either Cambrian or Ordovician age. The series at this point consists of fine-grained, thinly bedded, white and chocolate-coloured sandstones; micaceous shales; quartzites; and occasional conglomerates. The iron-ore body occupies a fault, and consists of lenticles and veins of hard solid hæmatite in a soft matrix of red and yellow limonite. The outline of the body is irregular. No reliable estimate of the ore available has been made. Analyses of shipments made by the Burma Corporation show the hard ore to average about 61 per cent. of iron and the soft material about 47 per cent.

The other iron-ore deposit is at Manmaklang, 2 miles east of Man Pwe and 2½ miles from the nearest point of the Burma Railways, where a siding has been made.

The country-rock at this point is limestone, in which are beds of sandstone. The iron ore usually occurs as masses of ore fragments separated by a little clay, and there are also bands of clay several feet thick alternating

with iron ore. At one point the ore is covered by a 10-ft. bed of travertine, but the other edges are with one exception contacts with surface soil. The exception is at the bottom of a shaft 40 ft. deep, where the ore is lying directly on a limestone surface. A shaft has been sunk 75 ft., but was still in ore when discontinued. The shape and extent of the deposit cannot be ascertained at the present stage of development, but the deposit is apparently of considerable size. Iron sulphide in the form of marcasite is present in small amounts, but the ore is largely limonite, probably containing also some hæmatite.

An approximate average percentage analysis of the ore as shown by shipments to the Burma Corporation's smelter is as follows: iron, 52; silica, 15; alumina, 6·5; and lime, 1·8.

Lead

Canada.—In *Memoir* 136 (No. 117 *Geological Series*), 1924, of the *Geological Survey of Canada* on the Arnprior-Quyon and Maniwaki areas in Ontario and Quebec, is a description by E. M. Wilson of the lead-ore deposits on Laflamme (Chats) Island, an area cut off from the mainland of Ontario by the narrow channel of Ottawa River. These deposits do not appear to have been officially described before.

In this district deposits of galena associated with calcite are known in several localities. In some cases they are merely aggregates occupying cavities in the Grenville limestone, but there are also veins occupying well-defined fault fissures.

The principal deposit is in Fitzroy township, and is owned and worked by the Kingdon Mining, Smelting and Manufacturing Company. It was discovered and worked for a short time about 40 years ago, but was not extensively developed until 1914; it has since been worked continuously.

Two productive veins occur on the Kingdon property, one of which, styled the main vein, occupies a fault fissure that cuts abruptly across the Granville limestone and its inclusions of diorite, granite and pegmatite.

The vein consists chiefly of calcite interlaminated with galena, and sometimes galena and blende. The second or north vein also occupies a fault fissure, the west side of which is Beekmantown dolomite and the east side Grenville limestone, indicating a downthrow on the west. This vein has been exposed for about 25 ft. and has a width of 2 to 2½ ft. It consists of calcite containing irregular zones of galena.

A concentrating plant designed to treat 200 tons of ore per day and a smelting furnace for producing 15 tons of pig lead per day have been installed. The concentrated material is reported to contain approximately: lead, 79 per cent.; zinc, 2 per cent.; and silver, 1·14 oz. per ton.

Australia.—An account of the newly-discovered silver-lead deposits of Mount Isa, Cloncurry District, Queensland, is given under the section "Silver" on page 380.

Mercury

China.—The mercury deposits of China have been described by F. R. Tegengren (*Geol. Survey China, Bulletin* 2, October 1920). The main mercury-bearing belt of country trends in a general N.E.–S.W. direction, and is principally confined to Kueichow Province and the adjacent parts of Szechuan and Hunan in the north-east and Yunnan in the south-west. The Kueichow plateau may be briefly described as a "horst" of older, rather gently folded rocks, mostly limestones and shales, ranging in age from probably pre-Cambrian to Carboniferous or Permian. The folding, with a N.N.E.–S.S.W. trend, probably took place in Mesozoic time, whilst the great lines of dislocation may be regarded as of Tertiary age.

The deposits occur in limestones of Ordovician, Devonian, Upper Carboniferous and Permian age, and in calcareous shales of Lower Carboniferous age. They consist of irregular veins and stockworks, interweaving brecciated layers of limestone or hard shale or disseminated in the rock as small crystals or aggregates of crystals. The deposits occur along several roughly parallel zones coinciding with the axis of folding, and with the chief lines of dislocation. With the cinnabar sometimes occurs native mercury, and onofrite (a sulpho-selenide of mercury) has been found occasionally in Wan-Shan-Ch'ang. Other associations are stibnite (especially on the quartz druses), calcite (abundant and often forming the cement of the brecciated layer), quartz (especially lining the walls of vugs), bitumen (in patches) and pyrite. The last mineral appears to be rare, except in the Nan-Mu-Ch'ang mine. Effusive rocks, such as quartz-porphyry and porphyrite are present in Southern Kueichow. The mercury content of the ore varies from under 1 to 4 per cent.

In the Lung-Men-Ch'ang mines in S.E. Szechuan (northern portion of the belt) the ore occurs along an anticline in the calcite cement of a brecciated layer of dark limestone (probably Ordovician), and is generally attached

to a thin, nearly horizontal layer of yellow clay. The average grade exceeds 1 per cent. of mercury. The Ta-Tung-La mines belong to the same broad anticline. The ore-bearing stratum is a brecciated layer 20 to 32 ft. thick in the Limestone Series. The cinnabar is often of the dark antimonial variety. Stibnite is abundant in vugs. Intermittent operations have been carried on here since the Ming dynasty (fourteenth century), and there are dumps containing millions of tons of rock.

The Wan-Shan-Ch'ang mines are the most important mercury mines of the country, and are briefly described in the Imperial Institute Monograph, *Mercury Ores* (1923, p. 59). Two well-defined ore-bearing horizons can be discerned ; the chief brecciated layer crops out along the precipices of the canyon, the other being 328 to 500 ft. above, on the slopes of hillocks rising above the mean plateau level. The former is the chief source of production, the ore being in innumerable veinlets in a limestone layer, 16 to 20 ft. in thickness. The mercury content of the picked ore of this lower layer averages 2·78 per cent. Mining in this case also dates back to the time of the Ming dynasty.

The production of mercury in China in 1901 amounted to 200 tons, and in 1914 to 130 tons, the consumption amounting to 510 and 370 tons respectively.

Details of mining and smelting are given in the same *China Survey Bulletin.*

Nickel

United States.—In *Economic Geology* (1924, **19**, 309) W. Lindgren and W. M. Davy contribute an article entitled " Nickel Ores from Key West Mine, Nevada," describing the nickel deposit at Key West mine and the character of its ore. A brief reference to this deposit was made in the Imperial Institute Monograph, *Nickel Ores* (1923, p. 70), but the article in question gives later information.

The deposit is associated with a basic dyke so much decomposed that its original character remains in doubt, but neighbouring dykes show the composition of a hornblendite. The chief primary minerals of the dykes are magnetite, pyrite, pyrrhotite, chalcopyrite and platinum. No pyrrhotite is now found in the Key West dyke, and it has been suggested that it has been altered to pyrite by the action of infiltrating solutions. Generally, the deposit is regarded as of magmatic origin similar to the nickel deposits of Sudbury, Ontario.

Only one complete analysis of the ore is published, and in this the nickel content is given as 5·38 per cent., and platinum metals 0·17 oz. per ton, with traces of gold and silver, but a shipment made some years ago showed copper, 2·30 per cent.; nickel, 1·79 per cent.; 0·13 oz. of platinum per ton; and traces of gold and silver.

The nickel minerals identified include pentlandite, the double sulphide of iron and nickel, and polydymite (Ni_4S_5) or violarite (NiS_2 ?).

The authors discuss the genesis of the ore minerals and suggest the order in which they were solidified from the magma.

Oil Shales

India.—The oil shales discovered a few years ago in the Amherst district of Burma have already been described in this BULLETIN (1923, **21**, 538). The following notes are taken from a discussion by R. H. Crozier of a paper on the refining of oil shale (*Journ. Inst. Petr. Tech.*, 1924, **10**, 558).

The deposit of oil shale which has been developed for the last three years lies in the valley of the Thaungyin River, near the Siamese border, some 60 miles E.N.E. of the port of Moulmein. Most of the work has been done on a concession comprising an area of 32 sq. miles. The main seam strikes N.-S., dips W. 12°, is 6 or 7 ft. in thickness, and outcrops on the eastern rim of the basin for about 5 miles. Calyx core drills have proved half a square mile to contain 13,500,000 tons of shale of an average grade of 33 gals. of oil per ton. Of this tonnage the main seam accounts for 7,500,000 tons, with an average grade of 45 gals. per ton.

Petroleum

France.—The Department of Mines, Ottawa, Canada, has published recently an account by C. Camsell and A. Buisson of the recovery of petroleum by shafts and galleries at Pechelbronn in Alsace, and at Wietze in Hanover (*Memorandum Series*, No. 10, June, 1924).

The Pechelbronn deposits are of Oligocene age. The oil is in a series of sandy layers from a few inches to 15 ft. thick, fifteen of which have been worked. The drainage gallery is driven, as far as possible, in the lowest part of the bed parallel with the floor, and from 7 to 15 inches above the marl, with a slightly upward slope to allow of the easy flowing of the oil. A drainage channel is dug in the centre of the gallery, and, occasionally, small ones on each side, to collect the oil dripping from the face, roof and sides

of the gallery. One gallery usually drains one bed, but a second gallery is always driven parallel to and above the main drainage gallery, at a distance of about 75 ft. The two galleries are connected by transverse drifts at certain intervals, the one nearest the face being left open, and the rest closed. Other subsidiary galleries and crosscuts may be driven in order to drain the whole deposit. Bore holes are driven at short intervals in the sides and roof to allow of the escape of gases from pockets that may have remained in the deposits. A "plenum," method of ventilation is adopted, air being brought to the working faces by means of galvanised iron pipes.

At present the cost of extraction by means of seepage is about 30 per cent. higher than by borings, but the difference will decrease very rapidly as improvements are made in the methods of operation.

The percentage yield of the Alsace crude light oils, of 0·875 to 0·895 specific gravity, by distillation is approximately as follows: light oils, 4; petroleum, 23; intermediate oils, 10; various lubricating oils, 35; paraffin, 2; residue, pitch and loss, 26.

From 1917 to 1921, inclusive, the production amounted to 68,563 tons. At present it is at the rate of about 100,000 tons per annum.

The shaft and gallery method of recovering oil was first adopted at Wietze, Hanover, in 1917. The method of working is in general similar to that applied at Pechelbronn, but, in lieu of a central drainage trough, wooden troughs are hung at the bottom of each wall of the galleries and these carry the oil to the pumping stations. About 61 per cent. of the total Wietze oil production is recovered from the shafts and galleries. It is reported that the mine has recently closed down.

Potash

Poland.—According to figures recently published (*U.S. Comm. Rep.*, 1924, June 2, p. 590), the output of potash salts from Poland during 1923 again showed an increase over that of the preceding year. The output during recent years has been as follows:

	Kainite.	Sylvinite.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*
1921	182	15,329	15,511
1922	2,520	43,562	46,082
1923	22,128	39,375	61,303

The output during 1923 was obtained principally from the deposits of Drohobycz and Stanislawow.

France.—The output of potash salts from the Alsace deposits during 1923 amounted to 1,026,042 tons, as compared with 844,767 tons and 646,796 tons in 1922 and 1921 respectively (*Chem. Trade Journ.*, 1924, **74**, 202).

Radio-active Minerals

Australia.—It is stated (*Indust. Aust. and Min. Standard*, 1924, **71**, 238) that Radium and Rare Metals Treatment Company has been formed in Melbourne to reopen the deposits of radio-active ore at Olary and Mount Painter, South Australia. The deposits at Olary which were discovered in 1906 contain carnotite associated with titaniferous magnetite. The ore was treated at Sydney from 1910 to 1915 for the recovery of radium. The Mount Painter deposits were located in 1911, but after a short time the work on them was abandoned.

Czechoslovakia.—Pitchblende has been found in promising quantities in some old copper mines at Durrmaul, west of Marienbad. The ore occurs in pockets and is said to contain 5·5 per cent. of uranium. A company has been formed to work the deposit (*U.S. Comm. Rep.*, 1924, March 24, p. 773).

Turkestan.—The Taya-Muyun radium ore deposits of Ferghana, Turkestan, were examined in 1922 by an expedition organised by the State Radium Institute, and an interesting account of them is given in *Eng. and Min. Journ.-Press.* (1923, **116**, 944).

The radio-active minerals, which have been deposited by circulating waters along fissures and cracks in chalk, consist chiefly of urano-vanadates of calcium and copper. Prior to 1914 about 1,000 tons of ore was extracted, of which about 700 tons was treated for the recovery of copper, uranium and vanadium. The radio-active residues and the remainder of the ore were treated at the State Radium Institute at Kama in the district of Yelabouga. The ore reserves ready for working are estimated at 5,000 tons, which would probably contain radium, 15 to 20 grams; uranium, 60 tons; vanadium, 90 tons; and copper, 120 tons.

Operations were resumed on the deposit in July, 1923, and 400 tons of ore produced. Several new occurrences of radio-active ore have been found near the mine.

Silver

Australia.—A short account of the new silver-lead deposits of Mount Isa, Cloncurry District, Queensland, has

already been given in this BULLETIN (1924, 22, 97). The following notes are mainly taken from reports by E. C. Saint-Smith (*Queensland Govt. Min. Journ.*, January 15, 1924, p. 9) and B. Dunstan (*Queensland Govt. Min. Journ.*, June 14, 1924, p. 200).

According to Dunstan, the silver-lead deposits of Mount Isa are associated with limestones, ferruginous shales, magnesites and "ribbonstone," a very finely banded quartzite, which appears to be the "chert" and "jasperoid" of Saint-Smith. These altered sedimentary rocks are considered to be of Silurian age, strike N.N.W.–S.S.E. and dip west at a high angle. The limestones have been in part altered to dolomites and magnesites, and these, by further replacement, have been changed to quartzites (ribbonstone). In the central disturbed zone are faults, foldings, contortions and crushed masses. Some of the rock outcrops are almost circular in shape, while very sharp "fish-hook" bends or angles occur in many places. In the deeper workings the carbonates are mixed with fine-grained galena carrying 17 to 70 oz. of silver per ton. The ore-bodies of this central area are formed in the spaces produced by the folding, rolling and separation of the stratified bands, and are therefore not fissure lodes. The individual thickness of the ore bands and lodes varies from a mere fraction of an inch to several feet, and while in some outcrops a number of fine regular bands of ore are to be observed, separated by bands of ironstone, clay or ribbonstone in the width of a foot. other occurrences show bands of ore a foot or more in section, and massed together to make up a formation perhaps 12 to 15 ft. in thickness. Again, very thick beds, perhaps each a foot in width, would be separated from one another by several feet of barren country, and then again numberless small bands of ore could be opened out over a section of about 50 ft. The abundance of the ore bands and lodes is a remarkable feature of the field, and although their outcrops along the surface have not yet proved to be continuous in the regularly bedded rocks, it seems almost impossible that they do not continue both along the surface and to considerable depths below.

Saint-Smith is of opinion that in this region of low rainfall, the zone of oxidation may be expected to persist to a considerable depth, carbonation of the sulphides being assisted by the presence of impure limestones and calcareous shales occurring in close proximity to the ore seams. A total of 80 tons of lead and 6,000 oz. of silver was contained in the gougers' ore; 154 tons of lead from this field had been sold in Cloncurry to the end of 1923.

According to A. W. Newberry (*Eng. and Min. Journ.-Press*, August 2, 1924, p. 168), the ore occurs as (1) bands of massive cerussite; (2) veinlets of cerussite, accompanied by 20 ft. of brown limonite; (3) veinlets of cerussite in kaolinised country; and (4) small tabular masses of finely crystalline galena.

United States.—Edson S. Bastin writes on the origin of certain rich silver ores near Chloride and Kingman, Arizona (*U.S. Geol. Survey, Bulletin* 750–B, 1924, p. 17).

The formation at all the mines consists of pre-Cambrian igneous and metamorphic rocks, which have been intruded by granite-porphyry of late Jurassic or early Cretaceous age. The veins are believed by Schrader to be connected in origin with this later intrusive, and to have been formed in Tertiary times. The oxidised ores extend from the surface to depths varying from 50 to 300 ft., and consist of cerargyrite and native silver. Proustite occurs in the lower part of this zone. The vein of the Distaff mine is in somewhat gneissic granite, strikes N.–S., parallel to the foliation of the granite, is nearly vertical and from 2 to 3 ft. in width. Cerargyrite was the most abundant mineral to a depth of 150 ft., and most of the native silver was found between the 200-ft. and 250-ft. levels. Wire silver occurs in small vugs in this ore. In the unoxidised ore, argentite is intimately associated with proustite, pearceite and polybasite (rare) in quartz-lined vugs. Minute amounts of chalcopyrite and blende are intercrystallised in places with the argentite. A specimen from the Empire mine, examined microscopically, showed an intergrowth of proustite and tennantite. The same thing is seen to be the case with ore from the Queen Bee mine, where the wall rock is mica-schist of pre-Cambrian age.

The Cupel mine, near Kingman, has produced ore amounting in value from $500,000 to $1,500,000, chiefly for its silver. Some of the ruby silver ore of this mine averaged 3,000 oz. of silver per ton. Cerargyrite and argentite also occurred.

There has been very little downward secondary enrichment in these veins. The conclusion that the rich ruby silver ores of the region are in the main primary offers encouragement to further exploration of the ore-bodies.

Tin

Nigeria.—C. Raeburn reports on the tinfields of Nassarawa and Ilorin Provinces, Nigeria (*Geol. Survey of Nigeria, Bulletin* 5, 1924). Brief abstracts of previous

reports on Nigerian tinfields by Falconer, and by Falconer and Raeburn, have appeared in this BULLETIN (1921, **19**, 427; and 1923, **21**, 655).

The area of the Nassarawa tinfield lies between 8°35′ and 9°45′ N. lat. and 8°00′ and 8°45′ E. long., totalling some 2,700 sq. miles. The general geology much resembles that of the Bauchi plateau; an old basal complex of schists, gneisses and gneissose granites (Archæan) has been invaded by fangs of the great Younger Granite batholith. Locally, and, as a rule, in very small patches, silicification has taken place along lines of fracture in this younger granite, accompanied by deposition of cassiterite and topaz. In the South Mada granite, silicification along fracture lines is very common, and one large patch of altered granite carries topaz and tinstone.

Pegmatites are widely distributed in the area. The Jemaa "lode" was a mineralised dyke of pegmatite traceable for a length of 60 ft., and about 15 ft. wide. The rock in composition and appearance was a muscovite-granite, fairly rich in cassiterite. Tourmaline was present in small quantity, and, among accessory minerals, were large iron garnets and well-formed zircons. The Amari dyke, south of the Jemaa, contains more tinstone than the latter, and bears tourmaline throughout. Accessory minerals are beryl, garnet and a little chalcopyrite. The tin-content of the albite rock, 40 ft. from the surface, is about 10 per cent. The country-rock is a biotite gneissose granite without cassiterite. The Randa dyke is 10 to 12 ft. wide, strikes N.–S. and dips W. at a low angle. The outcrop consists chiefly of a coarse, iron-stained, quartz-mica aggregate, containing tinstone. The Karama dyke has been worked. The whole of the outcrop is of albite.

The dykes richest in cassiterite are those in which the outcrops are mainly felspathic (Karama, Amari), or mainly quartz and mica (Randa, Amari, Jemaa). Normal pegmatites and dykes, consisting mainly of quartz, carry little or no tin.

Of the alluvial deposits, the most important are the terrace and stream bed deposits in hollows and pockets of rocky channels.

The Ilorin Province, which lies west of the last, has a tinfield 350 sq. miles in extent, near the Kabba boundary. The whole tin-producing district lies in the Niger Basin. Pegmatite dykes, striking N.–S. are common throughout the province, and, in the Eri (Odokeri) district, they carry cassiterite as well as tourmaline. They resemble those of Nassarawa Province. In the Odokeri Hills is a series of dykes, 3 to 4 ft. wide, which have been worked for tin.

The highest dykes consist of a coarse quartz-mica rock; others, of intermediate altitude, show quartz, mica and felspar, while, in the lower dykes, the cassiterite occurs in a matrix of very white, fine-grained albite, which contains in places large, well-formed, pinkish orthoclase crystals. Tinstone is present throughout, and, although not in great quantity, can be separated from the weathered rock with comparative ease. The country-rock is a dark green amphibolite. Excellent coarse, alluvial tinstone is found in the vicinity.

One dyke near Akatà, striking E.–W., and almost vertical, is about 2,000 ft. long and 6 to 8 ft. thick. The rock is even-grained and granitic in appearance, and carries fine-grained cassiterite. Other minerals present are orthoclase, albite, mica and quartz. Tourmaline appears to be absent.

At Sybu Kampi camp are dykes made up of quartz and mica with fine-grained crystallised tinstone. Small pink garnets are found in some of the dykes.

The Odara dykes consist of a fairly coarse quartz-mica-cassiterite aggregate. In one outcrop, where the dyke is felspathic, cassiterite is abundant.

The proportion of tinstone in the Ilorin dykes is probably less than in those of Nassarawa, but the dykes appear to have been more deeply weathered, and the large proportion of detrital material present allows of profitable exploitation. In this area the tin is derived solely from the pegmatites; there is no additional feed from sources connected with the Younger Granite as in Nassarawa Province.

NOTICES OF RECENT LITERATURE

The Dominions and Dependencies of the Empire. Pp. xv + 423, $8\frac{3}{4} \times 6$. (London: W. Collins, Sons & Co., Ltd., 1924.) Price 16s.

This is the first of a series of twelve volumes which have been undertaken as an intellectual supplement to the material side of the British Empire Exhibition.

The present volume comprises a series of articles by authors who have played an important part in the public life or administration of the lands which they describe, and who have therefore a first-hand knowledge of their subjects. Within the limits at their disposal the authors have been compelled to deal somewhat superficially with their subject, but enough information is given on history,

geography, administration, economics and outlook, not only to enable the reader to gain a clear idea of the true nature of the Empire, but to arouse an interest in subsequent volumes of the series in which the subjects are further developed.

The various sections are liberally adorned with representations of the coats of arms and badges of the respective Colonies, Dominions, etc. These are further dealt with in a short appendix.

Certain of the smaller British possessions, such as Gibraltar, Malta, Cyprus, Aden, etc., are described under a general heading, " Sea Power and Outposts of Empire," and not according to the continents which they adjoin. As stated in a foreword to this section by the Rt. Hon. L. S. Amery, this is due to the fact that " their primary importance lies in the part which they play in the general scheme of naval defence." The author of this section, Commander Dorling, D.S.O., stresses the value of the capital ship *versus* submarine and aircraft, and emphasises the importance of Singapore as a naval base.

The book would be more valuable if it possessed more maps. With the exception of small maps, illustrating the progress of the partition of Australia, and of a map of Malaya, there is a notable deficiency in this respect.

The work is interesting and instructive, and should find a place in every educational library.

THE UNIVERSITIES AND EDUCATIONAL SYSTEMS OF THE BRITISH EMPIRE. By Arthur Percival Newton, M.A., D.Litt., B.Sc., F.S.A., Rhodes Professor of Imperial History in the University of London. Pp. xxiv + 282, $8\frac{3}{4} \times 6$. (London : W. Collins, Sons & Co., Ltd., 1924.) Price 16*s*.

This work forms Volume X in the above-mentioned series. In his preface the author says that " to give a conspectus of so tangled a mass of regulations, forms of organisation, requirements, and so on, as is exhibited by the Universities of the British Empire, let alone its educational systems, is a task that is baffling in its complexity " ; and in regard to the educational systems, he adds that in view of the attempts at reform that are constantly going on, " it is difficult to keep one's information absolutely up to date." None the less, Professor Newton has produced a clearly written and concisely arranged treatise, full of useful facts and of undeniable interest ; and whatever changes may occur in future the volume should long remain useful as a work of reference for those concerned with organising or imparting higher education.

A HANDBOOK FOR TRAVELLERS IN INDIA, BURMA AND CEYLON, INCLUDING ALL BRITISH INDIA, THE PORTUGUESE AND FRENCH POSSESSIONS, AND THE INDIAN STATES. Eleventh edition, with eighty-five maps and plans. Pp. clvi + 728, 7½ × 5. (London: John Murray, 1924.) Price 24*s.*

It is not possible to describe this comprehensive guide-book in detail, and it must suffice to say that it is extremely practical in every respect. The maps and plans are excellent, and should be of great service to travellers. No one undertaking a journey of even small extent in the Indian Empire will regret the purchase of the book, which can also be recommended to general readers interested in India or any part of it, as a large amount of information is given on history, native races, religions, architecture and other matters, to which introductory articles are devoted in addition to special sections under the principal cities and provinces.

The section of the book dealing with Ceylon naturally forms only a small part of the volume, but it occupies over 40 pages and should be of much utility to travellers visiting that Colony.

AFRICA. By Evans Lewin, M.B.E., Librarian of the Royal Colonial Institute. Pp. 223, 7½ × 5. (Oxford: Clarendon Press, 1924.) Price 3*s.*

This is a concise geography of Africa, apparently intended for students wishing to acquire a good general knowledge of the continent without paying detailed attention to any particular country. To condense the geography of Africa into 220 octavo pages in large type seems a difficult task, but it has been accomplished by Mr. Lewin and the result is very satisfactory. It would hardly be possible to concentrate more real information on the subject into so small a compass, and the conciseness and practical arrangement of the little work are admirable.

Every aspect of the subject is dealt with—political geography, geological features, climate, people, plants and animals, minerals, agriculture, industries, means of communication, etc.—and a number of useful illustrations and diagrams are supplied. It may, however, be suggested that the next edition should contain a political map of the entire continent, and if possible a few similar maps of the more settled areas.

HANDBOOK OF THE LEEWARD ISLANDS. Compiled by F. H. Watkins, I.S.O. Pp. 308, 8½ × 5½. (London: The West India Committee, 1924.) Price 10*s.* 6*d.*

This is a further and very useful addition to the

collection of handbooks lately issued for various Colonies and Protectorates, several of which have been noticed in this BULLETIN. It gives a well-written and comprehensive account of the history, economic development and political conditions of the Leeward Islands, together with much general information on their climate, flora and fauna, educational and other institutions, commerce and industries. A specially interesting feature is the section entitled "Historical Outlines," which occupies no less than 60 pages of the book, and is preceded by a useful chronological table commencing with the year 1493—the date of the discovery of Dominica by Columbus. The vicissitudes experienced by the various islands during the last 400 years in the matter of political status, nationality, population and commercial prosperity are described in considerable detail. Another instructive section is that dealing with the cultivation of sugar, cotton, lime products, cocoa, coconuts, tobacco, etc., suitable allusion being made to the work of the Imperial Department of Agriculture.

The volume, which contains a sheet of small-scale maps and a number of full-page photographs, can be recommended as an authoritative and readable account of the Colony, and some of its features might usefully be adopted in other handbooks of the same kind. It would be of advantage if in future editions separate maps of the principal islands on a larger scale were provided.

THE COLONY OF FIJI, 1874–1924. Pp. 160, $9\frac{3}{4} \times 7\frac{1}{2}$. (Suva: The Government Printer, 1924.)

This is an official publication of the Fiji Government, issued on the completion of fifty years of British rule in the islands. It is published, as stated in an introductory note, with the object of "giving some information about the Colony and its resources, and inviting attention to the many possibilities for commercial enterprise and investment that lie within its fertile, but, to a very large extent, undeveloped islands." The book, which is written and arranged on rather unconventional lines, gives an excellent account of the people, natural features, resources, plants and animals of the Colony, and is illustrated by a series of good photographs. One of the most entertaining sections for many readers will be that entitled "Diary of an English Tourist in Fiji," which will certainly arouse in some a wish to visit this beautiful and relatively healthy part of the tropics.

Sociologists will be interested in the references to the Indian section of the population (now numbering some 60,000 out of a total of 157,000, and of whom over 44 per

cent. were born in the Colony), particularly in view of the "disintegration of the caste system" which has taken place even among the Hindu element. The results of Indian immigration are thus summarised: "That Indian immigration to Fiji has in many ways been a success admits of no question. It has been the main contributing factor to the development of the principal industries of the Colony, and the basic factor in the physical and mental development of a people whose lot in life and whose general conditions are immensely superior to what they would otherwise have been."

THE VEGETATION AND SOILS OF AFRICA. By H. L. Schantz and C. F. Marbut, with a section on the Land Classification of Africa by the Joint Authors and a Note on a Rainfall Map of Africa by J. B. Kincer. *American Geographical Society, Research Series*, No. 13. Pp. x + 263, 8 × 5, with 1 text map and 49 photographs, and with 2 maps in colour, each 36 × 33 in., folded in separate case. (New York: Published jointly by the National Research Council and the American Geographical Society, 1923.) Price $5·00 (to libraries $4·00).

This valuable book, whose object is to encourage the rational use of Africa's resources, is the outcome of an enquiry begun in 1918 by the organisation of technical advisers who compiled data for the American Commission to negotiate Peace. The groundwork was prepared in the Bureau of Plant Industry, in the Bureau of Soils and the Weather Bureau of the United States Department of Agriculture, the maps being subsequently revised as a result of a tour of the continent undertaken in 1919–20 by H. L. Schantz, in which he collected a number of soil samples.

The vegetation map is drawn to a scale of 1 : 10,000,000. Each vegetational formation is discussed in the text as regards botanical description, distribution, climatic conditions, soil conditions, natural production, agriculture and crop potentialities. The forest type of vegetation is estimated to cover 2,056,700 square miles out of a total land surface (without lakes) of 11,200,000 square miles. Of this area 1,841,500 square miles is classed as timber land (mangrove forest, tropical rain forest, temperate rain forest, oak-conifer forest and dry forest) and 215,200 square miles as woodland (thorn forest, temperate bush and oases). The grassland type covers 4,736,400 square miles, of which 4,156,000 square miles is savannah (bearing low trees) and 580,400 square miles grassland proper (free of trees). The remaining 4,406,900 square miles of the

land surface is desert. From the standpoint of agriculture about half the continent is productive and half non-productive. Of the productive land, the bulk is suited to tropical or sub-tropical agriculture and only one-seventh to temperate agriculture.

Inset in the vegetation map is a soil map on the scale of 1 : 25,000,000. Sixteen soil types are distinguished, and these are dealt with in the text under the headings of temperate and sub-tropical Africa (South Africa, Sudan and Atlas Region), arid Africa (Sahara and deserts of south-west and north-east Africa) and tropical Africa (Central Africa and Guinea).

The land classification map, on a scale of 1 : 10,000,000, is based on the vegetation and soil maps. It shows agricultural potentiality, the types of utilisation for which each area is suited and the degree of potential productivity within each type. A full explanation of the twenty-three graded types thus arrived at is given in the text.

The rainfall map on the scale of 1 : 25,000,000, an inset on the land classification map, is based on records of 757 stations.

Both maps and text are well produced, and the excellent photographs add considerably to the value of the work. The references to the vegetation of Africa are collected together and constitute a valuable bibliography to the subject, comprising about 450 entries. The fewer references to the soil section are given as footnotes.

Agricultural Conditions in Esthonia. A Short Survey compiled by Emil Vesterinen. Pp. 86, 5½ × 8. Second Edition, 1923. Obtainable from the Esthonian Legation, London.

This is a good account of agricultural and general economic conditions in the smallest of the new Baltic States which have broken off from the former Russian Empire. It demonstrates the enterprising character of the Esthonian people—a nation small in numbers, but well educated and progressive, and now rejoicing in its final delivery from economic subjection to alien landowners, which lasted for centuries and greatly hindered development. The booklet opens with a summarised history of the country, in which it is shown that the improved conditions began in 1860, with the enactment of laws under which a large part of the land was gradually redeemed—a process definitely completed in 1919, when the new Constitutional Assembly decreed that the remaining "baronial lands" should forthwith become the property of

the State ; the terms of compensation to be decided later. In subsequent chapters accounts are given of agricultural education, areas and production of the principal crops (potatoes, oats, rye, barley, flax and linseed, etc.), experimental work, dairy farming, agricultural societies (some of which received State assistance even from the former Russian Government), forestry, and the export of agricultural produce. A section is also devoted to the subject of Esthonian phosphorite, which has already been used on a small scale as a fertiliser and may prove an important factor in agricultural development if the deposits can be exploited at a sufficiently low cost.

The booklet is attractively printed and contains a number of illustrations of buildings, farming operations, etc., which add considerably to its interest for the general reader.

THE STORY OF THE MAIZE PLANT. By Paul Weatherwax. Pp. xv + 247, $7\frac{1}{2} \times 5\frac{1}{4}$. (Chicago: University Press, 1923.) Price $1·75.

The author of this little book, who is Associate Professor of Botany at the Indiana University, has done a useful task in gathering together so much information regarding the botany of the maize plant. He traces its history from the germination of the seed to the ripening of the fruit in a most interesting way, and includes particulars of the structure and physiology of the different organs, pollination, fertilisation, development of the seed-coat and endosperm, and similar matters. A useful summary of the principles of heredity and breeding as applied to the maize plant is also given. The book does not profess to be a complete treatise on maize, but there are brief chapters, occupying in all less than 30 pages, on the cultivation of the crop and the products and uses of maize. Perhaps the chapters of most general interest are the concluding ones, in which the author deals with the influence of maize in America both before the advent of the white man and also on modern American life, including art and literature. The numerous illustrations are in the main original and generally of a high standard, whilst there is a useful bibliography citing over 170 different items.

COMMERCIAL FRUIT AND VEGETABLE PRODUCTS. By W. V. Cruess, Associate Professor of Fruit Products, University of California. Pp. vii + 530, 9 × 6. (London: McGraw Hill Publishing Company, Limited, 1924.) Price *22s. 6d.*

This volume is devoted to descriptions of the various methods employed in the canning industry for preserving

fruit and vegetable products for use as food. It is based on lectures given by the author to students in fruit and vegetable products and is written chiefly from the viewpoint of the instructor rather than from that of the manufacturer. It consists of thirty chapters, each of which is followed by references to literature relating to the subject matter dealt with. Commencing with a brief description of the micro-organisms in relation to fruit and vegetable products, and a short history of the canning industry and the tin container, the general considerations with regard to the establishment of a cannery are discussed and the preparation and grading of fruit for canning are dealt with. The canning of various fruits, and the preparation of unfermented fruit beverages and syrups, are treated in detail, and descriptions are given of processes for the manufacture of jams, jellies, marmalades, preserves and confections of various kinds. The tomato products, which are numerous and of great importance in the United States, are considered in a special chapter. This is followed by an account of the sun-drying of fruits and vegetables as practised in California, which is almost the only locality in the United States where sun-drying of fruits is carried out, the chief products being prunes and raisins. Just as the American Civil War stimulated the canning industry, the Boer War and the World War are said to have stimulated the dehydrating industry. Commercially, dehydration is understood to mean the removal of water by artificial heat. This method is said to have certain advantages over sun-drying, but is somewhat more costly. The packing of dried fruits and vegetables plays an important part in the marketing of these products, and a special chapter is devoted to this subject. Several by-products are manufactured as the result of the fruit-canning industry; vinegar, for example, being made from uncultivated fruits, cores, peelings and other waste materials. The process of the manufacture of vinegar from these materials is described, also the preparation of pickles, coconut and olive oils, and citrus by-products.

A chapter is devoted to packing-cases, a subject which has received much attention in the United States during recent years. The provision of cases and crates is an important local industry, which absorbs about 6,000,000,000 board feet of timber annually. The results of various tests carried out at the Forest Products Laboratory are described and the relative merits of different woods and methods of construction are discussed. The concluding chapter treats of vitamins in relation to preserved fruit and vegetable products.

The book therefore covers a very wide field and summarises much scattered information on the subject of preserving fruit and vegetable foodstuffs. Although written for use in the United States, where the canning industry is of such great importance, the work should prove useful in many countries of the British Empire which have similar industries on a smaller scale, or which produce the raw materials required by such industries.

USES OF WASTE MATERIALS. The Collection of Waste Materials and their Uses for Human and Animal Food, in Fertilisers, and in certain Industries, 1914–1922. By Prof. Arturo Bruttini. Pp. xx + 367, 9½ × 6. (London : P. S. King & Son, Ltd., 1923.) Price 12s.

One of the subjects to be dealt with by an enquiry into the "Intensification of Agricultural Production," set up by resolution of the Fifth General Assembly (1920) of the International Institute of Agriculture, Rome, was the utilisation of waste materials by various countries during the war and since the cessation of hostilities. The present volume was prepared in connection with that enquiry. It was originally published by the Institute in French and later in Italian. The Italian edition contained a considerable number of additions, and the present translation into English has been so arranged as to blend the two preceding editions into one, whilst further additions were made during its preparation.

Following a section of 50 pages dealing with legislative and administrative methods for the utilisation of waste products as food- and feeding-stuffs, as fertilisers and in certain other industries, a summary of published information on the uses of waste materials is given, arranged under the headings of Human Food, Feed for Live Stock, Fertilisers, and Alcohol, Oils and other Industrial Products obtained from Various Residues. Owing to the wide field covered, the information given is necessarily very much condensed, but full references to original literature are given in the convenient form of footnotes. As illustrating the wide range of subjects dealt with, the following list, taken at random from the four main sections mentioned above, may be given. As human food : substitutes for bread, tea, coffee, cocoa, spices, meat, salad oils, etc. ; as feed for live stock : straw, leaves, twigs and young shoots, prickly pear, seaweed, flower bulbs, acorns and other wild fruits and seeds, rice bran and husks, residues of sugar refineries, distilleries and breweries, tomato residues, parings from vegetable ivory, wood shavings, feathers, chrysalids and synthetic fat ; as fertilisers : seaweed, vegetable

offal, molasses, tannery refuse, retting water from flax and hemp, wool and silk waste, soap-work residues, sewage and explosives ; for the production of alcohol, oils and other industrial materials : alcohol from straw, horse chestnuts, seaweeds and prickly pear ; oils from seed residues of wild plants, from grape seed, tobacco seed, lemon pips, and silkworm chrysalids ; fats from household refuse and sewage water ; paper pulp from cotton stalks ; and extraction of the vegetable pectin of fruit residues.

THE FORESTS OF NEW YORK STATE. By A. B. Recknagel, B.A., M.F., with an introduction by L. H. Bailey. Pp. xiii + 167, 7½ × 5. (New York : The Macmillan Co., 1923.) Price 12*s*.

The object of this book is to draw attention to the importance of the forests of New York to the citizens of that State. Seventy years ago, New York was pre-eminent in the lumber industry and five years ago in pulp and paper production. At the present time, however, large quantities of timber are imported which might be produced within the State, whilst the wood-using industries in the rural districts are steadily dwindling. Although primarily, therefore, of local interest, the problems discussed in the book are almost universal, and the arguments employed in advocating both a State and a national forest policy as applied to America will be of value to all in any way connected with forest conservation. The mode of treatment followed may be gathered from the chapter headings, which are : The Land and its Character, The Forest and its Character, The Lumber Industry and its Development, The Pulp and Paper Industry and other Wood-using Industries, Development of a State Forest Policy, Forestry as a Land Problem, Forestry as an Industrial Problem, and Forestry as an Investment. There is a useful bibliography relating to American forestry, not entirely restricted to New York.

THE CHEMISTRY OF RUBBER. By B. D. W. Luff, F.I.C. Pp. 232, 10 × 7½. (London : Ernest Benn, Ltd., 1923.) Price 25*s*.

During the last few years many advances have been made in the knowledge of rubber-compounding and vulcanisation, but no attempt has been made hitherto to collect and summarise this information. Mr. Luff's book is quite up-to-date and is therefore a welcome addition to the literature of the subject.

. The work has a wide scope, dealing not only with such questions as accelerators, compounding ingredients and other manufacturing problems, but also with rubber latex and the composition of raw rubber.

The author states that "no attempt has been made to describe plantation practice in detail, as there are numerous treatises devoted to that branch of the subject." A chapter is devoted, however, to the effect of the various processes in the preparation of raw rubber on its vulcanising properties.

While the book is of most direct interest to those connected with rubber manufacture, it will also be of value to the scientific planter.

TESTED METHODS OF MINERAL ANALYSIS. By B. T. Kitto. Pp. 125, $7\frac{1}{4} \times 5$. (London: H. F. & G. Witherby, 1924.) Price 7*s.* 6*d.*

The title of this little book is somewhat misleading, for in only one or two cases does the author describe the complete analysis of a mineral, usually the mode of determining the principal constituent only being indicated. Methods are described for the quantitative estimation of the common elements, and also of thorium, uranium, vanadium and zirconium. The methods are in outline those generally employed in routine mineral laboratories, but the detailed directions given in some cases either could not be carried out or would lead to inaccurate results. Some of the methods are out-of-date, whilst their more convenient modern equivalents are not mentioned.

CHEMISTRY OF THE RARER ELEMENTS. By B. Smith Hopkins. Pp. vii + 376, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: G. G. Harrap & Co., Ltd., 1923.) Price 15*s.*

In this volume Prof. Hopkins gives one of the most readable accounts of the chemistry of the rarer elements which has so far appeared.

After a discussion of the periodic system, he deals with each of the rarer elements according to that classification. An account is given of the discovery, occurrence, properties and uses of each element, the subject matter being supplemented by numerous references to original communications and patent specifications.

In addition to the less common "rarer elements," the author also considers molybdenum, tungsten, uranium, selenium and the platinum metals. The book can be recommended to all interested in the subject of the rarer elements.

BY-PRODUCT COKING. By (the late) G. S. Cooper, B.Sc. Second Edition, revised and enlarged by E. M. Myers. Pp. xv + 192, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Benn Bros., Ltd., 1923.) Price 12*s*. 6*d*.

The first edition of this work, which appeared in 1916, endeavoured to give in concise form an account of modern practice as free as possible from intricate technicalities. The fact that a second edition has been called for is evidence that the book is appreciated.

The author deals with such matters as the various types of by-product coking plant and their management, the recovery and conversion to marketable form of the many by-products obtained, and the chemical and physical tests necessary in connection with the several operations. The book concludes with a chapter on possible future developments in the industry.

The present edition differs from the earlier one mainly in that a chapter on "condensers and scrubbers" has been added.

The text is supplemented by numerous diagrams of plant, and the book will doubtless continue to be of service to all requiring a concise statement of current by-product coking practice.

BOOKS RECEIVED

INDUSTRIAL DEVELOPMENT IN SOUTH AFRICA. Compiled by the Department of Mines and Industries, in collaboration with the South African Railways and Harbours Administration. Pp. 219, $9\frac{1}{2} \times 7\frac{1}{4}$. (Pretoria: Government Printing and Stationery Office, 1924.)

PLANTES À FIBRES. Par Yves Henry. Pp. vi + 211, $7 \times 4\frac{1}{2}$. (Paris: Librairie Armand Colin, 1924.) Price 6 fr.

GRUNDLAGEN DER RÖSTE. Von Dr. Gerhard Ruschmann. Pp. x + 188, $8\frac{1}{2} \times 5\frac{3}{4}$. (Leipzig: S. Hirzel, 1923.)

DIE FASERSTOFFE DES PFLANZENREICHES. Von Dr. Ernst Schilling. Pp. viii + 320, $9\frac{1}{4} \times 6$. (Leipzig: S. Hirzel, 1924.)

THE CARBOHYDRATES AND THE GLUCOSIDES. By E. Frankland Armstrong, D.Sc., Ph.D., F.R.S., F.I.C. Fourth Edition. Pp. xi + 293, $9\frac{1}{2} \times 6$. (London: Longmans, Green & Co., 1924.) Price 16*s*.

THE VEGETABLE PROTEINS. By Thomas B. Osborne, Ph.D., Sc.D. Second Edition. Pp. xiii + 154, $9\frac{3}{4} \times 6$. (London: Longmans, Green & Co., 1924.) Price 9*s*.

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT. Revised by W. Harrison Martindale, Ph.D., F.C.S., and W. Wynn Westcott, M.B.Lond., D.Ph. Eighteenth Edition. Vol. 1. (London: H. K. Lewis & Co., Ltd., 1924.) Price 27*s*. 6*d*.

REPORT OF THE MOTOR FUELS COMMITTEE. Embodying other allied researches. Pp. vii + 352. (London: The Institution of Automobile Engineers, 1924.)

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Imperial Institute to the Dominion, Colonial and Indian Governments.

BRITISH HONDURAS TIMBERS

PART III

IN the following pages is given an account of the examination of six further timbers sent to the Imperial Institute from British Honduras. In Part I, published in this BULLETIN (1923, **21**, 569), the timbers dealt with were "banak" (*Myristica* sp., near *M. panamensis*, Hemsl.), "Santa Maria" (*Calophyllum* sp.), "sam" or "salm wood" (unidentified) and "black poisonwood" (*Mauria* sp.). Part II (*loc. cit.*, 1924, **22**, 1) was concerned with "bullet wood" (*Terminalia Buceras*, Benth. and Hook. f.), "nargusta wood" (unidentified), "pine wood" (*Pinus caribæa*, Morelet), and "tubroos wood" (*Enterolobium cyclocarpum*, Griseb.).

As in previous cases, the mechanical properties and working qualities of the six timbers now described have been determined in the timber-testing laboratory and the results communicated to the Imperial Institute Advisory Committee on Timbers, who after inspecting the materials, have given their opinion as to the purposes for which they could be utilised and their commercial possibilities in this country.

The six timbers are as follows: the information as to their local uses, etc., has been supplied by the Forestry Officer, British Honduras, and their botanical identity determined at Kew, so far as the material available allowed.

1. *Waika Chewstick* (unidentified).—Used as keels for boats and as sleepers; said to be ant-proof. Limited quantity available.

2. *Quamwood* (*Schizolobium* sp.).—Used for rafts.

3. *Cotton Wood* (*Bombax* sp.).—Only occasionally used; employed for dug-outs; is not lasting.

4. *White Moho* (*Hibiscus* sp. ?).—A very light wood when seasoned, used for similar purposes to balsa wood. Could be grown in quantity (second growth).

5. *Cypress* (*Podocarpus coriacea*, Rich.).—Resembles South American cypress in qualities. Only a limited quantity available.

6. *Sapodilla* (*Achras Sapota*, Linn.).—Used for sleepers and is a possible substitute for hickory; lasting. A fair quantity of this wood is available in the Colony.

Waika Chewstick

The specimens received at the Imperial Institute consisted of nine planks 10 ft. long, 6 to 18 in. wide and 1½ in. thick; two planks 10 ft. long, 8 in. wide and 4 in. thick; and one plank 7½ ft. long, 15 to 18 in. wide and 4 in. thick.

The wood was in sound condition and free from knots. The heartwood was light greenish-brown and the sapwood, which was about 3 in. wide, light pinkish-yellow. The grain was straight, fibrous (more so in the sapwood than the heartwood), fairly coarse and open. The bark was light brown and about ½ in. thick.

In *transverse section* the heartwood was light olive-green and the sapwood very light pinkish-brown. The pores or resin-ducts were very numerous, of medium size, and partially filled; they were distributed in undulating lines joined by soft tissue. The rays were seen as very numerous, straight, fine, light lines. The rings were indicated by the closer arrangement of the lines of soft tissue joining the pores, thus giving the wood an appearance of greater density in these zones; they averaged 5 to 8 to the inch.

In *radial section* the wood was slightly lighter in colour than in the transverse section. The pores were con-

spicuous as light brown, long grooves, partially filled with a resinous substance; the rays were visible as narrow, dull, pinkish-yellow bands; and the rings were indicated by the arrangement of soft tissue.

In *tangential section* the colour of the wood and the appearance of the pores were similar to those observed in the radial section. The rays appeared as numerous, short, dull, narrow lines, tapering at the ends and slightly lighter in colour than the surrounding wood: the rings were also indicated by a difference in colour.

Results of Mechanical Tests

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)*:				
Maximum calculated longitudinal shear	*lb./sq. in.*	440	358	393
Modulus of rupture	,,	12,370	10,030	11,060
Fibre stress at elastic limit	,,	8,130	6,850	7,440
Modulus of elasticity	,,	1,822,000	1,365,000	1,652,000
Elastic resilience	*inch-lb./cu. in.*	1·91	1·43	1·73
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	5,860	3,840	5,030
Fibre strength at elastic limit	,,	4,910	3,090	4,080
Modulus of elasticity	,,	1,815,000	1,345,000	1,576,000
Elastic resilience	*inch-lb./cu. in.*	6·76	2·96	4·56
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	5,710	4,420	5,030
Fibre strength at elastic limit	,,	5,260	3,950	4,420
Modulus of elasticity	,,	1,754,000	1,259,000	1,539,000
Elastic resilience	*inch-lb./cu. in.*	6·90	3·94	4·99
D.—*Compression test across the grain*:				
Load at elastic limit	*lb.*	6,050	3,200	4,880
Fibre stress at elastic limit	*lb./sq. in.*	1,530	810	1,240
E.—*Shearing tests along the grain*:				
Radial—				
Maximum load supported	*lb*	6,420	4,460	5,570
Shearing strength	*lb./sq. in.*	1,610	1,140	1,410
Tangential—				
Maximum load supported	*lb.*	6,610	5,360	6,010
Shearing strength	*lb./sq. in.*	1,670	1,390	1,530
Specific gravity		0·672	0·587	0·624
Weight per cubic foot	*lb.*	41·9	36·7	39·0
Moisture	*per cent.*	23·5	10·3	13·4

Results of Working Tests

(1) *Sawing.*—The wood can be cut readily with hand and power saws.

(2) *Planing.*—The wood planes easily, and as it is straight-grained there is no tendency to "pick up."

(3) *Boring.*—Good clean holes are obtainable with all tools, but there is a slight tendency to split.

(4) *Working with Gouge and Chisel.*—The wood cuts easily along and across the grain.

(5) *Nailing and Screwing.*—Nails and screws can be driven in with ease, and hold well.

(6) *Mortising and Dovetailing.*—The wood cuts readily in the mortising machine, and the joints have fair strength.

(7) *Turning.*—The wood turns well and a good finish is obtainable.

(8) *Polishing and Varnishing.*—The wood polishes readily and excellent results can be obtained. Varnishing gives satisfactory results.

(9) *Glueing.*—Glued joints have very little strength.

(10) *Staining.*—The wood takes stain well, a plain mahogany finish giving the best results.

Remarks

Waika Chewstick is a wood of medium weight and hardness; it is straight-grained, does not warp or check unduly, and though plain is of good appearance. It works easily with all hand and power tools, and finishes well. It is moderately elastic and has good transverse bending strength, but only medium crushing and shearing strengths. A comparatively large proportion of sapwood is present, but this is very little lighter and softer than the heartwood and not much weaker.

The Advisory Committee considered it to be a good, useful timber which would probably be found suitable for furniture and light fittings. It resembles certain grades of the Philippine woods known as red and white luan, which are now being marketed in this country, and would probably have to compete with these. The Committee were of opinion that Waika Chewstick might be expected to realise from 4*s*. 6*d*. to 5*s*. per cubic foot in

the United Kingdom, and they desired to be informed as to the likelihood of the timber being exported at this price. It would be essential for the logs to be shipped in good condition and free from "checks."

QUAMWOOD (*SCHIZOLOBIUM* SP.)

The specimens received at the Imperial Institute consisted of five planks 9¾ ft. long, 5 to 9 in. wide, and 1¼ in. thick; two planks 9¾ ft. long, 10 in. wide and 4 in. thick; and one plank 6 ft. 9 in. long, 20 in. wide and 4 in. thick.

The timber was in fairly sound condition, except for slight worm-attacks near the bark and some "black line" fungoid marking in the outer wood. It was comparatively free from knots. The wood was light greyish-brown with occasional orange bands. The boundary of the sapwood and heartwood was indefinite.

The grain was slightly alternating spiral, the outer wood showing this feature to a greater degree than the inner. The outer wood was denser and longer-fibred than the inner, which was coarse, open and soft for a diameter of 5 in., being similar in this respect to Balsa wood.

In *transverse section* the wood was light pinkish-grey with occasional pinkish-brown bands; it had numerous, conspicuous, uniformly distributed resin ducts. The rays were just visible to the naked eye as numerous, very fine, light lines. The rings were well defined by a broad band of rapid growth wood, then a narrow band of denser and darker wood followed by a fine, light line as boundary; they averaged from 3 to 5 to the inch. The pith was light brown, soft and spongy and about ⅜ in. in diameter.

In *radial section* the wood was light greyish-brown, with large, conspicuous resin ducts, partially filled, the arrangement of which indicated the slight alternating spiral grain. The rays appeared as numerous, light pink, narrow bands; the rings were indicated by the narrow bands of denser and darker wood.

In *tangential section* the colour and appearance of the resin ducts were similar to those observed in the radial section; the rays were seen as fine, short, tapering lines and the rings were indicated by bands of darker wood.

Results of Mechanical Tests

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)* :				
Maximum calculated longitudinal shear	*lb./sq. in.*	336	218	260
Modulus of rupture	,,	9,360	5,580	7,020
Fibre stress at elastic limit	,,	5,850	4,130	5,100
Modulus of elasticity	,,	1,360,000	1,228,000	1,302,000
Elastic resilience	*inch-lb./cu. in.*	1·30	0·94	1·12
B.—*Compression test along the grain (24 in. length specimen)* :				
Crushing strength	*lb./sq. in.*	4,840	4,000	4,390
Fibre strength at elastic limit	,,	3,780	2,930	3,390
Modulus of elasticity	,,	1,365,000	1,254,000	1,307,000
Elastic resilience	*inch-lb./cu. in.*	4·39	2·68	3·72
C.—*Compression test along the grain (8 in. length specimen)* :				
Crushing strength	*lb./sq. in.*	5,080	4,180	4,610
Fibre strength at elastic limit	,,	4,900	3,460	4,120
Modulus of elasticity	,,	1,179,000	931,000	1,06[illegible],000
Elastic resilience	*inch-lb./cu. in.*	8·11	4·35	6·27
D.—*Compression test across the grain* :				
Load at elastic limit	*inch-lb./cu. in.*	3,100	2,400	2,720
Fibre stress at elastic limit	*lb./sq. in.*	775	600	680
E.—*Shearing tests along the grain* :				
Radial—				
Maximum load supported	*lb.*	4,490	3,230	3,750
Shearing strength	*lb./sq. in.*	1,139	795	960
Tangential—				
Maximum load supported	*lb.*	4,450	3,700	4,110
Shearing strength	*lb./sq. in.*	1,112	932	1,030
Specific gravity		0·443	0·334	0·386
Weight per cubic foot	*lb.*	27·7	20·8	24·1
Moisture	*per cent.*	14·1	10·2	12·2

Results of Working Trials

(1) *Sawing.*—The wood cuts easily with hand and power saws.

(2) *Planing.*—A fairly smooth surface is obtainable with jack and smoothing planes.

(3) *Boring.*—Clean holes are easily obtained with all tools ; there is, however, a slight tendency to split.

(4) *Working with Gouge and Chisel.*—The wood cuts very easily, but shows a tendency to splinter.

(5) *Nailing and Screwing.*—Nails and screws can be driven in with ease, and hold well.

(6) *Mortising and Dovetailing.*—The wood cuts readily

in the mortising machine and the joints are of fair strength, failing by the splitting of the wood rather than by shearing or breaking.

(7) *Turning.*—The wood turns easily, but the fibre bundles tear out ; only a rough finish is obtainable with tools, but a good finish can be secured with glass-paper.

(8) *Polishing and Varnishing.*—These give satisfactory results.

(9) *Glueing.*—Fairly strong joints are obtainable, as the wood fails before the glue.

(10) *Staining.*—The wood takes stain well.

Remarks

Quamwood (*Schizolobium* sp.) is a light, fairly soft wood of nondescript appearance. It works easily with hand and power tools, and finishes fairly well.

The wood, which is similar in some respects to Balsa wood, has low strength in transverse bending and in compression along the grain, and gives a poor resistance to compression across the grain and to shearing.

The Committee regarded this wood as of comparatively little value in the United Kingdom market, except possibly for cheap-grade fittings. It might perhaps be used for plywood centres but would have to compete with American cotton-wood, which is excellent for this purpose and of which good supplies are available in London at about 5*d.* per foot super. Quamwood could not be expected to realise more than 4*d.* per foot under similar market conditions, even if supplied only in selected qualities.

COTTON WOOD (*BOMBAX* SP.)

The specimens received for examination consisted of four planks 11 ft. long, 13 to 30 in. wide, and 4 in. thick; 1 plank 8 ft. long, 27 in. wide and 4 in. thick ; and 16 planks 11 ft. long, 6 to 20 in. wide and 1½ in. thick.

The wood was light greyish-yellow to light brownish-white with occasional greyish-black discolorations and some " black line " markings. The grain was coarse, open,

and generally slightly alternating spiral. The specimens were in rather poor condition, the wood for several inches from the bark being decayed in all the planks, and the remainder showing signs of fungus. The timber had been attacked in places by wood-boring insects, whilst the larger planks were badly cracked at the centres.

In *transverse section* the wood was greyish-white to light brownish-white, with scattered, fairly large resin ducts. The rays were seen as thick, orange-brown lines, fairly widely spaced; the rings were inconspicuous, averaging from 3 to 6 per in., their boundary being a fine, brown line.

In *radial section* the wood was of a lighter shade, and the resin ducts were seen as large, conspicuous, scattered grooves. The rays appeared as very conspicuous brown flakes of varying width, whilst the rings were indicated by fine, light brown lines.

In *tangential section* the wood was similar in colour to the radial section and the resin ducts were even more conspicuous. The rays were visible as narrow, brown lines, tapering at the ends and varying between $\frac{1}{32}$ and $\frac{1}{8}$ in. in length; the rings were vaguely indicated by narrow, undulating, light brown bands.

Results of Mechanical Tests

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test* (*central loading*):				
Maximum calculated longitudinal shear	*lb./sq. in.*	287	253	275
Modulus of rupture		8,210	7,210	7,813
Fibre stress at elastic limit		6,770	5,770	6,092
Modulus of elasticity		1,145,000	929,000	1,030,000
Elastic resilience	*inch-lb./cu*	2·13	1·64	1·87
B.—*Compression test along the grain* (24 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	4,780	3,730	4,348
Fibre strength at elastic limit	,,	3,740	3,210	3,484
Modulus of elasticity	,,	1,228,000	828,000	1,087,000
Elastic resilience	*inch-lb./cu. in.*	5·21	4·18	4·75
C.—*Compression test along the grain* (8 *in. length specimen*):				
Crushing strength	*lb./sq. in.*	5,010	3,740	4,395
Fibre strength at elastic limit	,,	4,350	3,360	3,855
Modulus of elasticity	,,	1,400,000	989,000	1,139,000
Elastic resilience	*inch-lb./cu. in.*	7·11	3·15	5·38

	Maximum.	Minimum.	Mean.
D.—*Compression test across the grain :*			
Load at elastic limit . *lb.*	4,400	2,900	3,710
Fibre stress at elastic limit *lb./sq. in.*	1,118	742	943
E.—*Shearing tests along the grain :*			
Radial—			
Maximum load supported *lb.*	3,670	2,680	3,130
Shearing strength . *lb./sq. in.*	930	668	792
Tangential—			
Maximum load supported *lb.*	3,350	2,360	2,806
Shearing strength . *lb./sq. in.*	857	602	711
Specific gravity	0·420	0·296	0·362
Weight per cubic foot . *lb.*	26·2	18·4	22·6
Moisture . . . . . *per cent.*	12·2	5·4	9·0

Results of Working Trials

(1) *Sawing.*—The wood cuts easily with hand and power saws, but there is a slight tendency to tear up when cross-cutting.

(2) *Planing.*—The wood can be planed with facility, giving a good surface, but the end grain tends to tear.

(3) *Boring.*—All boring tools give good results.

(4) *Nailing and Screwing.*—The wood takes screws readily, but they do not hold firmly. Nails can be driven in easily and hold fairly well.

(5) *Working with Gouge and Chisel.*—The wood cuts easily, but shows a tendency to split.

(6) *Mortising and Dovetailing.*—The wood gives weak joints, and breaks rather than splits.

(7) *Turning.*—The wood can be turned rapidly, but the fibres tear out, leaving a rough surface with tools. Sand-papering gives good results.

(8) *Polishing.*—The wood requires a liberal application of polish, as it absorbs it readily but a good finish is obtainable.

(9) *Varnishing.*—Good results are obtainable.

(10) *Glueing.*—Fairly strong joints can be obtained.

(11) *Staining.*—The wood takes stain satisfactorily.

Remarks

Cotton wood is a soft, light timber, which works very easily with all hand and machine tools, and finishes moderately well. It had rather low strength in the transverse bending, compression and shearing tests.

The Committee considered that if the present samples are representative the timber would appear to be a useful wood, which should readily find a market in the United Kingdom for the sides and bottoms of drawers and the tops of wardrobes, backings for veneers, etc., and other similar purposes in furniture and cabinet work. If the wood is obtainable in satisfactory sizes, its use for such purposes would depend almost entirely upon its price.

White Moho (*Hibiscus* sp. ?)

The specimens received for examination consisted of one plank $7\frac{3}{4}$ ft. long, 10 in. wide and 4 in. thick; one plank $4\frac{1}{2}$ ft. long, 6 in. wide and 4 in. thick; and one plank 10 ft. long, 7 in. wide and $1\frac{1}{8}$ in. thick.

The wood was light brownish-grey and generally in sound condition. The grain was slightly alternating spiral, somewhat coarse, and of fairly open appearance.

In *transverse section* the wood was light brownish-grey with very numerous, small, evenly distributed pores. The rays were just visible to the naked eye as very narrow, orange lines: the rings were vaguely defined by a zone of soft, rapid growth wood, followed by a harder zone which was bounded on either side by narrow, mauve-coloured lines.

In *radial section* the wood was light brownish-pink and the pores were seen as long, brown, narrow, inconspicuous grooves, having practically no contents; their arrangement denoted slight alternating spiral grain. The rays were visible as numerous orange-brown flakes and the rings were occasionally indicated by mauve-coloured boundaries.

In *tangential section* the colour and the appearance of the pores were the same as in the radial section. The rays were visible as short, narrow, taper-ended, densely distributed, reddish lines, and the rings were indicated by undulating, mauve-grey bands.

Results of Mechanical Tests

The amount of wood received was insufficient for the whole of the usual tests and the compression test along the grain on 24 in. specimens was accordingly omitted.

	Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)* :			
Maximum calculated longitudinal shear . . *lb./sq. in.*	301	178	229
Modulus of rupture	8,470	4,980	6,510
Fibre stress at elastic limit	6,210	4,070	4,880
Modulus of elasticity .	1,201,000	783,000	976,000
Elastic resilience *inch-lb./cu.*	1·67	1·01	1·28
B.—*Compression test along the grain* (24 *in. length specimen*) :			
(No tests made.)			
C.—*Compression test along the grain* (8 *in. length specimen*) :			
Crushing strength . *lb./sq. in.*	4,290	3,610	3,890
Fibre strength at elastic limit ,,	3,680	3,090	3,410
Modulus of elasticity . ,,	1,316,000	755,000	1,003,000
Elastic resilience *inch-lb./cu. in.*	6·60	3·30	4·75
D.—*Compression test across the grain* :			
Load at elastic limit . *lb.*	2,070	1,600	1,810
Fibre stress at elastic limit *lb./sq. in.*	518	400	455
E.—*Shearing tests along the grain* :			
Radial—			
Maximum load supported *lb.*	3,310	2,290	2,720
Shearing strength . *lb./sq. in.*	817	569	676
Tangential—			
Maximum load supported *lb.*	4,440	2,720	3,570
Shearing strength . *lb./sq. in.*	1,070	680	866
Specific gravity	0·391	0·254	0·310
Weight per cubic foot . *lb.*	24·4	15·9	19·4
Moisture . . . . . *per cent.*	13·1	8·6	10·4

Results of Working Trials

(1) *Sawing.*—The wood can be cut easily with all hand and machine saws, but it tears slightly when cross-cut.

(2) *Planing.*—A good surface is obtainable with jack and smoothing planes, but a fine cut is necessary to secure good results across the grain.

(3) *Boring.*—Good results are obtainable with all boring tools.

(4) *Nailing and Screwing.*—Nails and screws can be driven in readily, and hold well.

(5) *Working with Gouge and Chisel.*—The wood cuts easily.

(6) *Mortising and Dovetailing.*—The wood cuts easily in the mortising machine, but the joints are not strong as the wood splits readily.

(7) *Turning.*—The wood tears slightly but cuts rapidly, and a good finish is obtainable with sand-paper.

(8) *Polishing.*—The wood is very absorbent, but a fairly good surface can be obtained.

(9) *Glueing.*—Strong joints can be obtained as the glue holds firmly, the wood breaking first.

(10) *Staining and Varnishing.*—Satisfactory results are obtainable.

Remarks

White Moho is a light, soft wood, of plain appearance. It does not warp or check, is free from knots, works readily with all hand and machine tools, and finishes fairly well.

The Committee considered that if the present samples are representative, the timber (like the cotton wood already described) would appear to be a useful wood which should readily find a market in the United Kingdom for many purposes, e.g. for the sides and bottoms of drawers, tops of wardrobes, backings for veneers, etc., and similar purposes in furniture and cabinet work. If the wood is obtainable in satisfactory sizes its use for such purposes would depend almost entirely upon its price.

CYPRESS (*PODOCARPUS CORIACEA*, RICH.)

The specimens received for examination consisted of two planks, 4 ft. long, 10 in. wide and 4 in. thick, and two planks 5 ft. long, 5 and 8 in. wide and 1⅛ in. thick.

The wood was light brownish-yellow in the rough state, and though badly cracked in places was in sound condition and free from knots. The grain was fairly straight, fine, close and even.

In *transverse section* the wood was light mauve-brown, and no pores or resin ducts were visible. The rays were just visible to the naked eye as numerous, very fine, orange lines. The rings were not conspicuous, having only a fine, dark line as boundary; they averaged from 12 to 18 to the inch. The pith was about ⅛ in. in diameter, reddish-brown, and shrunken.

In *radial section* the wood was light mauve-brown, sometimes yellowish-brown. The rays were seen as

narrow, orange flakes and the rings were indistinctly indicated by the dark boundaries.

In *tangential section* the wood was similar in colour to the radial section. The rays were very indistinct, being seen as orange-coloured lines tapering at the ends, whilst the rings were indicated by wavy, dark brown lines.

Results of Mechanical Tests

The amount of wood received was insufficient for the whole of the usual tests and the transverse bending test and the compression test along the grain (24 in. specimens) had to be omitted.

A.—*Transverse bending test (central loading)* :

(No tests made.)

B.—*Compression test along the grain* (24 *in. length specimen*) :

(No tests made.)

C.—*Compression test along the grain* (8 *in. length specimen*) :	Maximum	Minimum.	Mean.
Crushing strength . *lb./sq in.*	7,150	6,050	6,710
Fibre strength at elastic limit ,,	6,690	5,450	6,090
Modulus of elasticity . . ,,	1,760,000	1,389,000	1,594,000
Elastic resilience *inch-lb./cu. in.*	11·44	7·13	9·11
D.—*Compression test across the grain* :			
Load at elastic limit . *lb.*	5,300	4,000	4,580
Fibre stress at elastic limit *lb./sq. in.*	1,360	995	1,155
E.—*Shearing tests along the grain* :			
Radial—			
Maximum load supported *lb.*	5,930	4,510	5,270
Shearing strength . *lb./sq. in.*	1,520	1,150	1,340
Tangential—			
Maximum load supported *lb.*	6,080	4,280	5,360
Shearing strength . *lb./sq. in.*	1,560	1,080	1,360
Specific gravity	0·555	0·445	0·518
Weight per cubic foot . *lb.*	34·6	27·8	32·4
Moisture . . . . . *per cent.*	12·6	10·1	11·4

Results of Working Trials

(1) *Sawing.*—The wood cuts readily with hand and machine saws.

(2) *Planing.*—The wood planes easily without any tendency to pick up, and an excellent surface can be obtained.

(3) *Boring.*—All boring tools give good results.

(4) *Nailing and Screwing.*—Nails and screws can be driven in easily, and hold firmly; there is little tendency to split.

(5) *Working with Gouge and Chisel.*—The wood cuts fairly well.

(6) *Mortising and Dovetailing.*—The wood cuts easily, but not very cleanly, in the mortising machine, and the joints obtainable are fairly strong.

(7) *Turning.*—The wood turns well, gives a good surface with tools, and finishes well with sand-paper.

(8) *Polishing.*—An excellent finish is readily obtainable.

(9) *Varnishing.*—Good results are obtainable.

(10) *Glueing.*—Glued joints have moderate strength.

(11) *Staining.*—The wood takes stain fairly well.

Remarks

This Cypress wood is a firm, moderately light timber of fairly good appearance, somewhat similar to yellow cedar. It works well with most hand and machine tools, and finishes excellently. It is not very strong and breaks easily, but it should be useful for carpentry, interior work and cheap furniture.

The Committee regarded it as a good, useful timber, although somewhat hard and heavy for a coniferous wood. They considered that, if offered in sound condition and at competitive prices, it would probably find a market in the United Kingdom for many purposes where strength is not required.

SAPODILLA (*ACHRAS SAPOTA*, LINN.)

The specimens received for examination consisted of one plank 5 ft. long, 21 in. wide and 4 in. thick; two planks 10 ft. long, 19 and 13 in. wide, and 4 in. thick; and seven planks 10 ft. long, 7 to 15 in. wide and 1½ in. thick.

The wood was in fairly good condition, but was badly cracked in places and showed numerous superficial "checks." The grain was fairly fine and compact, and moderately straight, but occasionally gently undulating with some tendency to alternating spiral. The heart-

wood was reddish-brown, and the sapwood, which was about 2 in. wide, of a lighter tint.

In *transverse section* the wood was dark reddish-brown, with fairly numerous, small-sized pores, usually arranged compactly in radial groups. The rays, which were very numerous, appeared as close, fine, light lines ; the rings were not clearly marked, but seemed to be indicated by the distribution of light, concentric lines of soft tissue, the boundary being a poreless zone where these lines were most widely separated.

In *radial section* the wood was of a lighter shade, and the pores were seen as pinkish-brown grooves completely filled with a resinous substance. The rays appeared as narrow, lustrous flakes of the same colour as the ground, whilst the rings were indicated by narrow bands of slightly darker wood.

In *tangential section* the colour and pores appeared similar to those of the radial section, and the rays were just visible as fine, short, light lines, tapering at the ends. The rings were indicated by bands of darker wood and by the absence of pores in these bands.

Results of Mechanical Tests

		Maximum.	Minimum.	Mean.
A.—*Transverse bending test (central loading)* :				
Maximum calculated longitudinal shear	*lb./sq. in.*	778	536	648
Modulus of rupture	,,	21,800	14,870	17,970
Fibre stress at elastic limit	,,	13,110	10,690	11,670
Modulus of elasticity	,,	2,518,000	2,175,000	2,362,000
Elastic resilience	*inch-lb./cu. in.*	3·60	2·57	3·01
B.—*Compression test along the grain* (24 *in. length specimen*) :				
Crushing strength	*lb./sq. in.*	9,7[illegible]0	7,630	8,960
Fibre strength at elastic limit	,,	7,410	6,890	7,120
Modulus of elasticity	,,	3,030,000	2,270,000	2,568,000
Elastic resilience	*inch-lb./cu. in.*	9·18	7·14	8·10
C.—*Compression test along the grain* (8 *in. length specimen*) :				
Crushing strength	*lb./sq. in.*	9,820	7,930	9,040
Fibre strength at elastic limit	,,	7,550	6,720	7,160
Modulus of elasticity	,,	3,228,000	1,748,000	2,657,000
Elastic resilience	*inch-lb./cu. in.*	10·00	6·26	7·70
D.—*Compression test across the grain* :				
Load at elastic limit	*lb.*	12,000	8,500	10,550
Fibre stress at elastic limit	*lb./sq. in.*	2,960	2,110	2,620

		Maximum.	Minimum.	Mean.
E.—*Shearing tests along the grain :*				
Radial—				
Maximum load supported	*lb.*	9,670	7,410	8,240
Shearing strength .	*lb./sq. in.*	2,380	1,820	2,070
Tangential—				
Maximum load supported	*lb.*	11,000	9,040	9,800
Shearing strength .	*lb./sq. in.*	2,720	2,220	2,430
Specific gravity		1·178	1·033	1·103
Weight per cubic foot .	*lb.*	73·5	64·5	68·9
Moisture	*per cent.*	28·8	11·3	19·5

Results of Working Trials

(1) *Sawing.*—The wood is difficult to cut with hand-saws but less so with power-saws. The fine sawdust is irritating to the nostrils.

(2) *Planing.*—Jack and smoothing planes are hard to use but give good results. The radial surface " picks up."

(3) *Boring.*—The wood is too hard for the use of gimlets or bradawls, whilst morse drills and centre and auger bits heat up, and the wood splinters.

(4) *Nailing and Screwing.*—Nails bend over when driven in, and the wood splits. It is necessary to drill nearly full-sized holes for screws.

(5) *Working with Gouge and Chisel.*—The wood cuts fairly well, but shows a tendency to chip.

(6) *Mortising and Dovetailing.*—The wood is hard to cut in the mortising machine, but the mortised and dovetailed joints have good strength.

(7) *Turning.*—The wood cuts moderately easily in the lathe ; a good result is obtainable with tools, and an excellent finish with sand-paper.

(8) *Polishing and Varnishing.*—Satisfactory results are obtained.

(9) *Glueing.*—Glued joints show fair strength.

(10) *Staining.*—The wood takes stain well.

Remarks

Sapodilla is a very hard, heavy wood of good appearance, difficult to work with hand and power tools but finishing excellently. It shows good resistance to bending, crushing and shearing, and possesses great stiffness,

as is shown by its high modulus of elasticity. The irritating sawdust, however, and the readiness to "check" in a warm, dry atmosphere, are disadvantages.

The wood might be suitable for ornamental furniture and should find many uses in building and carpentry where great strength is required. It seems possible that it might also be of service for the piles of bridges, etc., but this would depend on its durability under water, and tests in this direction might be carried out in the Colony.

The Advisory Committee described it as a fine wood but too hard and heavy for ordinary furniture or cabinet work, and considered that the irritating qualities of the sawdust would be a serious obstacle to its use in the United Kingdom. If, however, prices and quantities are satisfactory, it might be considered for railway sleepers, as soon as facilities can be provided in British Honduras for sawing the timber to the standard sizes required.

THE CHARACTERS OF INDIAN MYROBALANS

PART II

IN this BULLETIN (1924, 22, 123) particulars were given of thirty-seven samples of myrobalans received from India, derived from various species of *Terminalia*, but mostly from *T. Chebula*. In continuation of this investigation twelve further samples have been received, comprising ten forms of *T. Chebula* from Madras and the Punjab, and one sample each of *T. tomentella* from Burma and *T. travancorensis* from Madras.

The following tables summarise the results of the examination of the twelve samples. Table A shows their colour, appearance, dimensions, and the relative proportions of flesh and stone, and Table B their chemical composition and the quality of the leather they produce. In order to facilitate comparison between the different samples, a column is included in Table B giving in each case the amount of tannin calculated for fruits containing 10 per cent. of moisture. This basis has been adopted in preference to that of moisture-free material, as it more

TABLE A

Sample.	Label.	Weight of sample.	Colour.	Appearance.	Average length.	Average diameter.	Average weight.	Flesh.	Stone.
		lb.			*in.*	*in.*	*grams.*	*Per cent.*	*Per cent.*
1	*Terminalia Chebula*, Retz., Chingleput Division, Madras.	4	Light yellowish-brown.	Fairly plump. Fairly prominent ridges.	0·94	0·45	2·10	55·1	44·9
2	*Terminalia Chebula*, Retz., East Salem Division, Madras.	6½	From yellowish-green to fairly dark brown.	Plump. Slight furrows.	1·07	0·84	5·06	86·1	13·9
3	*Terminalia Chebula*, Retz., East Salem Division, Madras.	4	From light yellowish or greenish-brown to dark reddish-brown.	Plump. Furrows ranging from slight to deep.	0·93	0·59	2·10	83·0	17·0
4	*Terminalia Chebula*, Retz., East Salem Division, Madras.	6½	Light yellowish or greenish-brown.	Fairly plump to plump. Slight to deep furrows.	1·20	0·69	3·70	75·7	24·3
5	*Terminalia Chebula*, Retz., East Salem Division, Madras.	4¼	Light yellowish to reddish-brown, mostly with a greenish tinge.	Fairly plump. Fairly prominent ridges.	1·07	0·64	3·38	77·4	22·6
6	*Terminalia Chebula*, Retz., East Salem Division, Madras.	3¾	Light yellowish-brown with a greenish tinge.	Shrunken. Fairly prominent ridges.	0·97	0·50	1·96	80·5	19·5
7	*Terminalia Chebula*, Retz., East Salem Division, Madras.	5¼	Light greenish-yellow to dark reddish-brown.	Plump. Slight furrows.	1·05	0·59	2·59	75·0	25·0
8	*Terminalia Chebula*, Retz., East Salem Division, Madras.	4	From light yellowish to dark reddish-brown; some with greenish tinge.	Fairly plump. Mostly with fairly deep furrows.	1·19	0·82	5·00	77·8	22·2
9	*Terminalia Chebula*, Retz., East Salem Division, Madras.	3¾	From light yellowish to dark reddish-brown; some with greenish tinge.	Fairly plump. Slight to deep furrows.	1·37	0·61	2·99	79·1	20·9
10	*Terminalia Chebula*, Retz., Kangra Division, Punjab.	8	Yellowish to dark reddish-brown.	Somewhat shrunken irregularly. Prominent ridges and secondary ridges.	1·59	0·75	6·62	78·0	22·0
11	*Terminalia tomentella*, Kurz, Insein Division, Burma.	6	Yellowish to dark reddish brown.	Very shrunken with very irregular ridges.	1·14	0·75	4·02	52·5	47·5
12	*Terminalia travancorensis*, W. & A., Tinnevelly Division, Madras.	7	Light to medium brown.	Appearance quite distinct from the others. Surface rather irregular, more or less furrowed.	0·75	0·42	1·30	59·5	40·5

TABLE B

Sample.	Label.	Composition (expressed on material as received).					Tannin expressed on material containing 10 per cent. moisture.	Tintometer readings.		Leather produced.	
		Moisture	In-soluble matter.	Extractive matter (non-tannin)	Tannin.	Ash.		Red.	Yellow.	Colour.	Texture, etc.
		Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Per cent.				
1	*Terminalia Chebula*, Retz., Chingleput Division, Madras.	9·6	47·8	11·8	30·8	2·2	30·7	1·4	3·7	Greyish-brown.	Fairly firm and soft, and fairly plump.
2	*Terminalia Chebula*, Retz., East Salem Division, Madras.	10·5	32·7	16·5	40·3	1·5	40·5	1·5	6·2	Fawn.	Firm, somewhat harsh and rather thin.
3	*Terminalia Chebula*, Retz., East Salem Division, Madras.	10·1	34·7	15·6	39·6	2·2	39·6	2·5	9·4	Mid-brown.	Rather harsh and stiff, and rather thin.
4	*Terminalia Chebula*, Retz., East Salem Division, Madras.	9·8	39·8	13·5	36·9	1·8	36·8	1·4	6·2	Mid-brown.	Rather harsh and stiff, and rather thin.
5	*Terminalia Chebula*, Retz., East Salem Division, Madras.	9·6	33·0	11·0	46·4	1·7	46·2	0·6	2·9	Pale yellowish-buff.	Firm, fairly soft, plump.
6	*Terminalia Chebula*, Retz., East Salem Division, Madras.	9·1	31·9	13·1	45·9	1·6	45·4	0·5	2·9	Pale yellowish-buff.	Firm, fairly soft, plump.
7	*Terminalia Chebula*, Retz., East Salem Division, Madras.	8·9	43·4	16·1	31·6	1·8	31·2	2·4	11·0	Brown.	Rather harsh and stiff, and rather thin.
8	*Terminalia Chebula*, Retz., East Salem Division, Madras.	8·6	37·5	13·8	40·1	2·0	39·5	0·9	5·2	Fawn.	Rather stiff, firm, fairly plump.
9	*Terminalia Chebula*, Retz., East Salem Division, Madras.	8·5	37·9	14·3	39·3	1·9	38·7	1·3	5·8	Fawn.	Rather stiff, firm, fairly plump.
10	*Terminalia Chebula*, Retz., Kangra Division, Punjab.	8·3	39·2	26·2	26·3	2·4	25·7	2·5	9·5	Brown.	Fairly stiff, harsh, moderately plump.
11	*Terminalia tomentella*, Kurz, Insein Division, Burma.	7·3	57·4	20·8	14·5	2·3	14·1	3·6	20·8	Brown.	Fairly stiff, harsh, moderately plump.
12	*Terminalia travancorensis*, W. & A., Tinnevelly Division, Madras.	8·7	46·3	13·0	32·0	2·3	31·5	1·3	5·0	Fawn.	Firm, plump and distinctly softer than the others.

nearly represents the actual condition of myrobalans as marketed.

The myrobalans, like those described in the previous report, varied in shape from long, comparatively narrow fruits, as in the case of Sample No. 9, to almost spherical fruits such as those of Sample No. 2. The sample of *Terminalia travancorensis* (No. 12) differed widely from the others, the fruits being much smaller, of very dull appearance, and lacking the greasy feel characteristic of myrobalans.

The results of the tanning trials show that, as in the case of the samples dealt with in this BULLETIN (1924, **22**, 123), the dark-coloured fruits generally produced darker leathers than the lighter fruits. Sample No. 1, however, proved to be a notable exception, since, although the fruits were almost as pale as those of samples Nos. 5 and 6 which furnished the palest leather, they produced leather which was much darker. The quality of this leather, however, was in general more satisfactory than that furnished by most of the other samples.

Sample No. 12 (*T. travancorensis*) gave the most interesting results in the tanning trials. Although the fruits were of unattractive appearance and rather dark, the leather which they produced was pale, plump, firm, soft and altogether of excellent quality. It differed materially in character from the leathers furnished by all the other species and varieties of myrobalans recently examined at the Imperial Institute.

Comparing the present results with those previously reported, the following points may be noted. The percentages of tannin quoted are those expressed on fruits containing 10 per cent. of moisture.

No. 1.—These fruits from the Chingleput Division, Madras, described as *T. Chebula* and containing 30·7 per cent. of tannin, were somewhat smaller but otherwise very similar in appearance to those of the earlier sample No. 13 from this Division, described as "*Terminalia* sp., Black Kadukai," which contained 26·9 per cent. of tannin. The proportion of flesh in the fruits (viz. 55·1 per cent.) is much lower than in the other samples of *T. Chebula* (Nos. 2–10).

Nos. 2 to 9.—It was shown in the previous report that, in general, the samples richest in tannin were those from the Salem Divisions of the Madras Presidency. The earlier samples of *T. Chebula* from this region contained from 41 to 49 per cent. of tannin, two samples from the East Salem Division (Nos. 25 and 26) containing 41 and 44 per cent. With the exception of sample No. 7 (which contained only 31·2 per cent.) the present eight samples of *T. Chebula* fruits from the East Salem Division all contained high percentages of tannin, viz. 36·8 to 46·2. Some of the fruits in sample No. 7 were rather blackened, but not more so than specimens in some of the other samples from this Division; the leather produced by No. 7 was, however, appreciably darker in colour than that obtained with the other samples from the East Salem Division, and it was in fact the darkest of all the leathers produced by the present set of samples.

No. 10.—This sample of *T. Chebula* from the Kangra Division, Punjab, containing only 25·7 per cent. of tannin, was identical in appearance with the two samples (Nos. 32 and 33) previously examined from the Division, which contained over 10 per cent. more tannin.

No. 11.—These *T. tomentella* fruits from Burma were similar in character to the samples previously examined (Nos. 4 and 5) and contained even less tannin, viz. only 14·1 per cent. as compared with 16·1 and 19·2 per cent. in the previous cases.

No. 12.—As already mentioned these fruits of *T. travancorensis* from the Tinnevelly Division of Madras were quite distinct in appearance from all the other specimens of myrobalans recently examined at the Imperial Institute, and produced a pale leather of much better quality than that obtained with any of the *T. Chebula* samples. Moreover, though the proportion of stone to flesh was higher than in the *T. Chebula* fruits, the percentage of tannin expressed on the entire fruits was fairly good, viz. 31·5. It was therefore suggested that if the sample was representative and the fruits are available in commercial quantities, it might be worth while to consider marketing them as a distinct variety.

INVESTIGATIONS OF PAPER-MAKING MATERIALS

In the following pages is given an account of the results of examination of a number of materials sent to the Imperial Institute recently, with a view to ascertaining their suitability for the manufacture of paper. In all cases the material was first submitted to chemical analysis in order to ascertain the percentage of cellulose present, and then digested with caustic soda under conditions similar to those employed for the preparation of paper-pulp on a commercial scale. Specimens of the paper produced from these materials are available for inspection at the Imperial Institute.

1. Bamboo from Mauritius

The attention of the Department of Agriculture in Mauritius has recently been devoted to the possibility of utilising the small bamboo of the island, believed to be *Bambusa nana*, as a source of paper-pulp. This bamboo is largely grown in Mauritius as a hedge-plant, and at present the quantities available for exploitation are stated to be small, but there are thousands of acres in the centre of the island that might be planted with bamboo if the material was of sufficient value for paper-making to justify its cultivation. The yield of stems from an experimental area is reported to be approximately 20 tons per acre. This represents several years' growth, and as the growth of ratoon shoots is slow, a further period of several years would have to elapse before the area could be cut again.

Pulp-making trials were conducted in Mauritius and two samples of the pulp, together with specimens of stems, were sent to the Imperial Institute for examination. The pulp proved to have been imperfectly digested and the present report deals only with the results of examination of the stems.

The samples of stems were described by the Department of Agriculture as follows:

1. "Ripe bamboo stems, full length."
2. "Fully developed immature bamboo stems."

In each case the stems, which had been cut into 18-inch lengths, were ⅛ to ⅜ in. in diameter and bore lateral shoots at most of the nodes. In the "immature" sample (No. 2) all the stems were green, whereas the "ripe" stems (No. 1) were in some cases yellow and their lateral shoots were more fully developed.

The results of chemical analysis of the material as received, and of the thicker stems of each sample after removal of the lateral shoots, are given in the following table. Corresponding figures obtained at the Imperial Institute for the stems of *Bambusa Tulda* from India and *Arundinaria alpina* from East Africa are shown for purposes of comparison.

	Moisture. Per cent.	Ash. Per cent.	Cellulose. Per cent.	Cellulose expressed on moisture-free material. Per cent.
No. 1 (Ripe)				
As received	9·7	3·1	45·0	49·8
Stems only	9·7	—	47·0	52·0
No. 2 (Immature)				
As received	9·7	2·0	48·5	53·7
Stems only	9·7	—	49·7	55·0
Bambusa Tulda	8·6	2·5	53·4	58·4
Arundinaria alpina	9·5	3·6	47·5	52·5

The lengths of the ultimate fibres of the four materials are as follows:

	Maximum. mm.	Minimum. mm.	Mean. mm.
Mauritius bamboo			
No. 1 (Ripe)	3·7	0·5	1·9
No. 2 (Immature)	3·3	0·5	1·6
Bambusa Tulda	3·0	1·8	2·4
Arundinaria alpina	2·7	1·6	2·3

Paper-making trials were carried out with the samples as received, and also on the "immature" stems (No. 2) after removal of the lateral shoots. The results, expressed on the materials in the condition in which they reached the Imperial Institute, are shown in the following table in comparison with corresponding figures for *B. Tulda* and *A. alpina.*

The conditions of treatment which were found to give the best results with the *B. Tulda* from India and *A. alpina* from East Africa proved just sufficiently drastic in the case of the present samples to produce pulps capable of being reduced in the beater. The pulps from the three

Trial.	Sample.	Caustic soda used. Parts per 100 parts of material.	Caustic soda used. Parts per 100 parts of solution.	Conditions of digestion. Time.	Conditions of digestion. Temp.	Parts of caustic soda consumed per 100 parts of material.	Yield of dry unbleached pulp.
				Hours	°C.		Per cent.
A	No. 1	20	4	7	160	14·6	32
B	No 2[1]	20	4	7	160	14·7	36
C	No. 2[2]	20	4	7	160	14·7	34·5
Bambusa Tulda		20	4	7	160	11·8	48
Arundinaria alpina		20	4	7	160	11·6	34

[1] *Stems as received* [2] *Stems after removal of lateral shoots.*

trials (A), (B) and (C) produced strong brown papers of similar character, and bleached fairly readily to a cream colour. The bleached pulps furnished opaque papers of good strength and quality, and would be suitable for the commercial production of high-grade paper.

The results of the investigation show that the species of bamboo represented by the present samples from Mauritius is capable of producing pulp equal in quality to that yielded by the allied species *Bambusa Tulda*, although the yield in the present case was somewhat low and corresponded more nearly to the amount furnished by the East African bamboo (*Arundinaria alpina*). It will be seen that Sample No. 2, described as "fully developed immature stems," contained a slightly higher amount of cellulose than the sample of "ripe" stems, No. 1.

Owing to the limited amount of stems available it was not possible in the present instance to carry out paper-making trials with the "ripe" stems (No. 1) stripped of the lateral shoots. The results obtained with No. 2 however appear to indicate that no material advantage would be gained by removing these shoots, but further experiments with a larger quantity of the bamboo would have to be conducted to decide the question.

2. Elephant Grass from Sierra Leone

The elephant grass which is the subject of this report was forwarded to the Imperial Institute by the Commissioner of Lands and Forests, Sierra Leone, in April, 1924.

The material consisted of grass stems varying in diameter from 0·5 to 1·3 in. and cut into lengths of 3½ ft.

Most of the stems were considerably stouter than those of samples of elephant grass previously received at the Imperial Institute from Uganda, Nyasaland, Nigeria, and other parts of Africa, though otherwise similar in general appearance.

The grass as received was found to contain :

	Per cent.
Moisture	13·5
Ash	3·1
Cellulose in material as received	44·9
Cellulose expressed on moisture-free material	51·9

The ultimate fibres measured from 0·5 to 3·7 mm. with an average of 1·4 mm.

Paper-making trials were made with the stems, after being split and cut into 1-in. lengths, with the following results, which are expressed in each case on the grass as received :

Trial.	Caustic soda consumed.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of grass.	Yield of dry pulp.	
	Parts per 100 parts of grass.	Parts per 100 parts of solution.	Time.	Temp.		Unbleached.	Bleached.
			Hours.	° C.		*Per cent.*	*Per cent.*
A	16	4	5	140	8·6	46	43
B	16	4	7	140	9·8	44	41
C	20	4	5	160	12·3	41	39

Trials A and B furnished pale brown pulps of similar character, bleaching easily to a good white. The papers obtained from the unbleached pulp were firm and strong, but showed many specks of incompletely disintegrated material, particularly that made from the pulp from trial A. The bleached pulps yielded papers which were also strong and of good quality, but not quite free from specks.

Trial C produced more thoroughly reduced pulp, which bleached satisfactorily and furnished paper free from specks. The bleached and unbleached papers showed little difference in strength from those furnished by the pulps obtained in trials A and B.

As already mentioned a large proportion of the present sample consisted of considerably stouter material than

samples of African elephant grass previously examined at the Imperial Institute, and was probably of older growth. The conditions of digestion which usually gave satisfactory results in the earlier investigations were therefore not sufficiently drastic in this case. Consequently the papers obtained from the pulps produced by the mild treatment used in trials A and B, although sufficiently homogeneous for many purposes, contained non-disintegrated particles of fibrous material, appearing as specks which had partially resisted the bleaching action. The more drastic conditions employed in trial C were required to produce a thoroughly satisfactory pulp although there is no doubt that for some classes of paper the intermediate treatment given in trial B would be found sufficient.

The present investigation has thus shown that under suitable conditions this elephant grass from Sierra Leone will yield a readily bleachable pulp, producing strong paper of good quality, similar to that previously obtained at the Imperial Institute from elephant grass from other localities ; but that material of the character of the present sample requires rather more drastic treatment than do thinner stems, the yield of pulp, though good, being in consequence somewhat lower than in the latter case.

3. Bardy Reed from Iraq

Specimens of a plant known in Iraq (Mesopotamia) as bardy reed were received through the Department of Overseas Trade in June, 1923. The reed is stated to grow in large quantities between Basra and Amara.

The sample consisted of pieces of reeds about 15 in. long, 1 in. broad and 0·3 in. thick, and of a greyish-yellow colour.

The reeds as received were found to contain :

	Per cent.
Moisture	12·2
Ash	5·8
Cellulose in material as received	38·2
Cellulose expressed on moisture-free material	43·5

The ultimate fibres measured from 0·3 to 2·4 mm. with an average of 0·9 mm.

The results of the paper-making trials were as follows:

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of reeds.	Yield of dry pulp expressed on reeds as received.	
	Parts per 100 parts of reeds.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached	Bleached.
			Hours.	° C.		*Per cent.*	*Per cent.*
A	16	3	5	140	—	—	—
B	{16 20	3 3	5 2}	140	15·0	37	26

The treatment in trial A was insufficient to break up the material completely, but the sample was not sufficient for a second trial under more drastic conditions, and further soda was therefore added to the product of trial A and the boiling continued for two hours in trial B. The pulp thus obtained did not break up satisfactorily in the beater, and although the paper made from it was fairly strong and of a light brown colour it showed many fine pieces of incompletely disintegrated material.

The pulp did not bleach well, even strong treatment yielding only a buff-coloured paper, still containing some fibre which was incompletely reduced. The paper furnished by this partially bleached pulp was fairly strong and generally similar to that obtained from the unbleached pulp.

From the foregoing results it appears that the bardy reed is not a promising paper-making material, and that it would need somewhat drastic treatment to convert it into satisfactory pulp. This would involve the consumption of a large quantity of soda, whilst only a comparatively low yield of bleached pulp would be obtained.

The shipment of the reeds would be unremunerative owing to their bulky nature and the low yield of pulp obtainable from them. The material might be converted in Iraq into pulp for export, but this procedure is not likely to be commercially successful.

It may be mentioned that a sample of " Berdie " reeds from the Persian Gulf, apparently of identical origin to the present sample, was examined at the Imperial Institute in 1909 and found to yield 34·5 per cent. of dry unbleached pulp of somewhat unpromising character.

4. *Costus afer* from Uganda

Costus afer, a plant belonging to the Natural Order Zingiberaceæ, with erect stems 10 to 12 ft. long, is found scattered through tropical Africa, from the west coast to the east. It is cultivated in Lower Dahomey, where the outer part of the stem is used for basket-making. In the Victoria Nyanza region of Uganda, it is very common under forest and semi-forest conditions, and a supply of the stems collected in that Protectorate was furnished by the Director of Agriculture for trial as a paper-making material in August 1923.

The sample consisted of grass-like stems, about ½ inch in diameter. The stems were rather weak and brittle, mostly light brown, with nodes every few inches; the upper nodes bore small sheathing leaves. The material as received was wet and slightly mouldy, and it was therefore air-dried before investigation.

Chemical examination of the air-dried material gave the following results:

	Per cent.
Moisture	12·9
Ash	4·0
Cellulose	44·7
Cellulose expressed on moisture-free material	51·3

The ultimate fibres measured from 0·5 to 2·8 mm. with an average of 1·5 mm.

The results of the paper-making trials are given in the following table:

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Yield of dry, unbleached pulp, expressed on the air-dried material.
	Parts per 100 parts of material	Parts per 100 parts of solution.	Time.	Temp.		
			Hours.	° C.		*Per cent*
A	20	4	5	140	9·6	48
B	20	4	6	160	11·6	43

The conditions of trial A were sufficient to break up the material, but the paper produced from the pulp thus obtained showed many specks, probably derived from the more resistant material in the nodes. The pulp bleached

fairly readily to a cream tint. Both bleached and unbleached papers were well felted and of good strength.

Trial B gave a pulp which furnished brown paper of good strength and fairly free from specks. The pulp bleached with some difficulty, but the bleached pulp furnished white paper of good strength and quality.

The results of the investigation show that the yield of pulp obtainable from *Costus afer* is very satisfactory, being about the same as that usually furnished by esparto grass. The pulp felts well and furnishes paper of satisfactory quality; it bleaches well, though with some difficulty, and then yields strong white paper which could be used in the production of writing and printing papers.

5. *Amomum Granum-Paradisi* from Uganda

Amomum Granum-Paradisi, which is closely related to the preceding plant, *Costus afer*, also occurs in tropical Africa. It possesses a slender rhizome with erect leafy shoots 4 to 5 ft. long. The seeds of this plant, together with those of *A. Melegueta*, form the Grains of Paradise, at one time imported from West Africa as a spice and now chiefly used in veterinary medicine. The plant grows freely in the swamps and low-lying regions of Uganda and a supply of the stems from that country was received with those of *Costus afer*. It was stated that the plant could be procured in large quantities.

The sample consisted of thin stems bearing light brown sheathing leaves. The material as received was wet and slightly mouldy, and it was accordingly air-dried before investigation.

Chemical examination of the air-dried material gave the following results:

	Per cent.
Moisture	11·1
Ash	8·4
Cellulose	38·5
Cellulose expressed on moisture-free material	43·3

The ultimate fibres measured from 0·5 to 2·5 mm., with an average of 1·1 mm.

The following results were obtained in the paper-making trials:

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Yield of dry unbleached pulp expressed on the air-dried material.
	Parts per 100 parts of material.	Parts per 100 parts of solution.	Time.	Temp.		
			Hours.	°C.		*Per cent.*
A	16	4	5	140	8·8	44
B	20	4	6	160	12·4	35

Under the conditions of trial A the material was not completely reduced, but the pulp obtained was sufficiently disintegrated to yield brown paper of good strength. The pulp bleached with some difficulty, and then furnished a strong white paper, which however showed a small amount of insufficiently reduced fibre.

Trial B gave a well disintegrated pulp which furnished hard, rather "rattly" brown paper of good strength, and bleached with some difficulty. The bleached pulp yielded white paper similar in strength and quality to the unbleached product.

The results of the investigation show that *Amomum Granum-Paradisi* furnishes a hard, tough, fairly opaque, "rattly" paper, somewhat resembling that obtained from the allied plant *Hedychium coronarium.*

The pulp bleaches well, though with some difficulty, and furnishes strong white paper suitable for use in the production of writing and printing papers.

6. *Abutilon tortuosum* from South Africa

Specimens of the stem of *Abutilon tortuosum* were forwarded to the Imperial Institute by the Chief, Division of Botany, Union of South Africa, in August, 1923. It was stated that the plant grows wild in parts of the Transkei and has given promising results under cultivation.

The stems had been freed from the bark and cut into pieces 2½ ft. long and with a diameter of ⅛ to ½ in. They were chemically examined with the following results:

	Per cent.
Moisture	10·0
Ash	0·9
Cellulose in stems as received	46·5
Cellulose expressed on moisture-free stems . .	51·7

The ultimate fibres measured from 0·5 to 1·3 mm. with an average of 0·9 mm.

Paper-making trials made with the stems gave the following results, expressed on the material as received:

Trial.	Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of stems.	Yield of dry pulp.	
	Parts per 100 parts of stems.	Parts per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
			Hours.	°C.		*Per cent.*	*Per cent.*
A	16	3	6	140	9·1	—	—
B	16	3	9	160	13·0	50	43
C	20	3½	6	160	16·1	33	28

Treatment under the conditions of trial A proved insufficient to reduce the material, but by increasing the temperature and time of digestion as in trial B a more satisfactory result was obtained. The pulp could not, however, be entirely disintegrated in the beater, and could not be bleached.

The increased amount of soda used in trial C produced a better result, yielding a light brown pulp which was completely disintegrated and bleached fairly readily to a good white tint. The paper produced from both unbleached and bleached pulps was somewhat harsh in character and fairly strong.

The results of examination show that the treatment of these *Abutilon tortuosum* stems as a paper-making material requires an abnormally high consumption of soda (owing to the large proportion of pith present) and furnishes only a low yield of pulp, and it is therefore doubtful whether the stems could be profitably employed for the purpose. The pulp, however, although composed of very short ultimate fibres, felts well and yields paper of fairly good strength and quality.

7. Waste Cotton Bolls from Egypt

In the *Third Annual Report*, 1922, *of the Cotton Research Board, Egypt* (see this Bulletin, 1924, **22**, 1923), Dr. Gough, Director of the Entomological Section, Ministry of Agriculture, in dealing with measures to control the attack of the pink bollworm in Egypt, suggested that every cultivator should be compelled to bring in a certain

quantity of the dead bolls remaining in the field after the cotton has been picked, and that these should be taken to some central place and destroyed. In order to recover some part of the expense incurred by the Government in the collection of the bolls, Dr. Gough subsequently suggested that the bolls might perhaps be utilised in some way. He therefore forwarded a large quantity to the Imperial Institute for paper-making trials.

The material received consisted of damaged and unripe cotton bolls, together with broken husks and some loose cotton. The bolls were partly open, and in many cases had a short piece of stalk attached. The lint was in poor condition, a large part of it being immature and most of it stained or mouldy, whilst the seeds were badly damaged by insect attack and mould.

The sample was composed of husk 34 per cent.; seed 45 per cent.; lint 20 per cent.; and loose dirt and dust 1 per cent.

On analysis it was found to contain:

	Per cent.
Moisture	11·6
Ash	4·6
Cellulose in material as received	33·5
Cellulose in moisture-free material	37·9

The lint, separated by hand from the husks and seeds, contained 72·8 per cent. of cellulose, equivalent to 82·4 per cent. in the moisture-free lint.

Paper-making trials were carried out with the entire material, and also with the husk and lint separately. The following results were obtained:

Trial.	Material.	Caustic soda used. Per 100 parts of material.	Caustic soda used. Per 100 parts of solution.	Conditions of digestion. Time.	Conditions of digestion. Temp.	Parts of caustic soda consumed per 100 parts of material.	Yield of dry pulp. Unbleached.	Yield of dry pulp. Bleached.
				Hours.	° *C.*		*Per cent.*	*Per cent.*
A	Material as received	20	4	5	140	13·5	29	23·5
B	do. do.	20	4	5	160	15·4	25	21
C	Husk only	20	4	5	160	14·4 [1]	23	—
D	Lint only	12	2	5	140	6·4	66·5	62

[1] *The spent liquor in this case was too dark to permit of accurate estimation.*

The pulp from trial A, prepared from the whole material as received, was sufficiently disintegrated except for the

presence of particles derived from the husk and stalk ; it yielded paper of good strength and of medium brown colour, but showing many black specks and shrinking somewhat on drying. The pulp bleached with some difficulty, and then furnished a cream-coloured paper of good strength which showed only a few fine specks.

The pulp produced in trial B under more drastic conditions yielded a paper which was slightly darker than that obtained in trial A, but showed only a few fine specks and was of good strength. The pulp bleached with difficulty, yielding a paper of equal quality to that obtained by the less drastic treatment in trial A.

The husk alone (trial C) yielded only a low percentage of pulp of very dark brown colour. The paper obtained from this pulp shrank excessively on drying, giving a rough, rather brittle sheet of poor strength. No attempt was made to bleach the pulp, as it was evident that the husks of the bolls are unsuitable for paper-making.

The pulp obtained from the hand-separated lint in trial D was well broken up, and yielded a pale mauve-brown paper of good strength. The pulp bleached readily and furnished a good white paper, which did not shrink in drying and was of satisfactory strength.

These experiments showed that the husks of the bolls were unsuitable for paper-making, for which purpose the seeds also are valueless. Attempts were therefore made to separate the lint from the bolls in as clean a state as possible for separate treatment. Satisfactory results could not be obtained by means of either the saw-gin or the roller-gin, as in each case the product included some seed and husk, whilst much lint was left behind with the seed. A better result was obtained by lightly grinding the bolls and then sifting ; much of the seed, husk and stalk (which had become coarsely ground) passed through the sieve, together with some lint, whilst the bulk of the lint, still containing a fair amount of seed and husk, remained on the sieve. The " crude lint " thus separated in the laboratory amounted to only 22 per cent. of the original material, leaving 78 per cent. which would have no value except as fuel. It is probable, however, that a better separation giving a somewhat larger yield of the

"crude lint" could be obtained in working on a large scale with suitable machinery.

The "crude lint," prepared in the manner described above, furnished the following results when treated with caustic soda (trial E):

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of material.	Yield of dry pulp.	
Per 100 parts of material.	Per 100 parts of solution.	Time.	Temp.		Un-bleached.	Bleached.
		Hours.	° C.		*Per cent.*	*Per cent.*
16	4	5	140	11·5	51	46

The pulp thus obtained was sufficiently disintegrated except for a quantity of small black particles resembling those in the pulp obtained in Trial A from the whole material as received. It yielded a paper which was superior to that of trial A, being less harsh and not shrinking on drying, of equal strength, rather lighter tint, and somewhat less speckled with fine particles.

The pulp bleached with some difficulty and then yielded paper of good strength, similar to that furnished by the bleached pulp from the whole material as received, but with the advantage that it was of a slightly lighter tint, which however did not, of course, approach the good white colour of the paper obtained from the hand-separated lint in trial D.

The results of this investigation show that when treated as in trials A and B the original material yields a pulp which can be made into brown paper suitable for wrapping purposes, or, after bleaching, can be used for producing cream-coloured paper of fair quality.

As might be expected, the clean lint separated by hand yields a bleached pulp of excellent quality and produces paper similar to white rag paper, but it may not prove possible to devise a process that could be profitably used on a commercial scale for separating the lint in the requisite state of purity.

A "crude lint," containing some seed, husk and debris, can be prepared fairly easily from the waste bolls, and furnishes a bleached pulp which is slightly superior to

that obtained from the whole material. The use of this "crude lint" would effect a saving in heat and soda, but it is doubtful whether these advantages would be sufficient to compensate for the labour and expense involved in its preparation, particularly as it forms only a small proportion of the waste bolls and special machinery would have to be devised for the purpose.

The waste bolls yield only 23·5 per cent. of bleached pulp and their transport to Europe would therefore not be remunerative. The "crude lint," prepared by grinding and sifting, gives a good yield of bleached pulp, viz. 46 per cent., but is objectionable for paper-making owing to the presence of the particles of husk, which would appear as specks in the paper. The waste bolls or the "crude lint" prepared from them could, however, probably be utilised in Egypt for the manufacture of paper for local use.

The results of the investigation described above were fully discussed with pulp importers and with a mechanical engineer who has had considerable experience in similar problems.

The pulp importers agreed that it would be useless to export the original material and considered that no manufacturer of white paper would use the "crude lint," whilst pulp made from the "crude lint" would be unsaleable to paper-makers owing to the specks of husk present. Further, it was stated that a brown pulp made from the original material would not be saleable in the United Kingdom as no brown paper is now manufactured here, the whole supply being imported, chiefly from Sweden and Finland.

The opinion was expressed that there would be no possibility of utilising the material for export unless clean, white cotton could be obtained from it for the manufacture of a white pulp.

The engineer who was consulted thought that it would be a very difficult matter to devise a machine for extracting clean lint from the bolls, and considered that in any case the separation would be too expensive for the recovered lint to be sold at a remunerative price.

On the whole, therefore, it seems probable that the

only profitable method of employing the waste bolls would be to utilise them in Egypt, without preliminary preparation, for the manufacture of brown wrapping paper for local use or possibly for export.

8. Arrowroot Refuse from St. Vincent

The arrowroot refuse ("bittie") which is the subject of this report was forwarded to the Imperial Institute by the Administrator of St. Vincent in September 1923.

It was stated that "bittie" consists of the fibro-vascular bundles of the rhizomes of *Maranta arundinacea* which are left after the starch has been extracted, and that at the present time it is not used for any economic purpose. In these circumstances it was desired to ascertain whether paper pulp could be prepared from the material, of which it is estimated that 500 to 1,000 tons are available annually.

The sample consisted of matted, pale brown, fibrous material, mixed with much non-fibrous matter.

The "bittie" was found to contain:

	Per cent.
Moisture	12·5
Ash	5·1
Cellulose in "bittie" as received	32·6
Cellulose expressed on moisture-free "bittie"	37·3

The ultimate fibres measured from 0·3 to 1·1 mm., with an average of 0·6 mm.

It was found that much of the non-fibrous material present could be removed by washing the "bittie" with boiling water. The resulting residue contained 48·9 per cent. of cellulose expressed on the moisture-free material.

A paper-making trial was carried out on the "bittie" as received with the following results:

Caustic soda used.		Conditions of digestion.		Parts of caustic soda consumed per 100 parts of bittie.	Yield of dry unbleached pulp expressed on bittie as received.
Parts per 100 parts of bittie.	Parts per 100 parts of solution.	Time.	Temp.		
		Hours.	*°C.*		*Per cent.*
20	4	6	140	15·0	35

The pulp obtained under the above conditions contained fragments of the material which had not been

completely disintegrated. It gave a fairly strong but harsh paper, which, on drying, shrank to the extent of about 15 per cent., expressed on the length of the sheet. The pulp bleached fairly easily, and then yielded a harsh "rattly" paper of fair strength, which also shrank considerably on drying.

The results of this investigation show that "bittie" is of little value for paper-making, as it gives a rather low yield of pulp which furnishes a harsh parchment-like paper that shrinks considerably on drying. Moreover, the amount of caustic soda consumed in the process of digestion is unusually high. Although the pulp bleaches fairly readily the paper furnished by the bleached pulp is of an unsatisfactory character.

ARTICLES

CEMENT MANUFACTURE AND ITS POSSIBILITIES IN THE CROWN COLONIES AND PROTECTORATES

PART II

THE first section of Part I of this article published in this BULLETIN (1924, 22, 173), described the various kinds of cements used in building, and the methods employed in their manufacture. This was followed by particulars relating to deposits of materials which might be suitable for cement-making which have so far been discovered in British West Africa, the results of tests carried out with these materials at the Imperial Institute and elsewhere, and the possibilities of cement manufacture in that region. In the present part, the British Crown Colonies and Protectorates of East Africa, from the Sudan to Southern Rhodesia, are dealt with on the same lines.

SUDAN

For many years past there has been a large consumption of cement in connection with the various irrigation works under construction. The quantities of Portland cement imported during 1921 and 1922 were, however, only 6,562

and 5,904 tons respectively owing to the fact that much of the cement required is now manufactured locally.

The factory for the manufacture of Portland cement for use in the Blue Nile dam and irrigation works is controlled by the Sudan Government, and is situated close to the dam at Makwar.

The limestone used is obtained from the Mashata quarries, about 30 miles from the cement factory. The deposit is covered by a small overburden and its extent has not been determined. The clay required is obtained from pits immediately adjoining the cement factory, whilst the gypsum is brought from a deposit on the Red Sea. The cement-making plant comprises six vertical kilns having a total capacity of 1,200 tons of cement weekly, ball mills for grinding and the necessary power plant. Local wood is used as fuel for the power plant, whilst a mixture of English foundry coke and locally produced charcoal is used in the kilns. The wet process of manufacture is used, the raw materials being briquetted before being burnt. The cement produced complies with the requirements of the British Standard Specification.

According to the *Report of the Govt. Chemist* for 1922 numerous analyses of calcareous materials have been made at the Wellcome Tropical Research Laboratories at Khartoum. Very few deposits of satisfactory limestone have been located so far in the Sudan, the material usually being either dolomitic or merely calcareous clay. Samples from the Red Sea hills, however, have been found to contain over 98 per cent. of calcium carbonate, as was also the case with specimens from Roseires, Segada and Om Nabadi.

British Somaliland

Only a small quantity of cement is at present used in Somaliland, but as limestone, clay and coal all occur in the Protectorate it appears probable that, if a demand should arise, cement could be produced locally. The following statement has been supplied to the Imperial Institute by Mr. R. A. Farquharson, M.A., M.Sc., Government Geologist to British Somaliland.

Large deposits of limestone belonging to several geological ages exist in the Protectorate. These include

the massive Coastal limestone which is composed largely of coral; Eocene limestone, comprising massive fine-grained yellowish and greyish-white chalky varieties; Jurassic limestone, usually fine-grained and compact and occurring mostly in the form of slabs; and a crystalline limestone probably of Palæzoic age. No chemical analyses of any of these have been recorded, but microscopical examination of the Coastal and Eocene limestones has shown them to be comparatively free from impurities, such as iron oxide and silica. A considerable amount of Eocene limestone is regularly burned in kilns in Burao and elsewhere and yields lime of good quality. Coastal limestone occurs in quantity within a mile or two of Berbera and large ridges of Eocene limestone exist at a distance of 8–10 miles from Berbera along a very level plain.

Except for a soapy clay of the nature of montmorillonite which occurs about 20 miles south-east of Berbera (see this BULLETIN, 1924, **22**, 66) no clays of commercial value have so far been found. Yellowish clay-shales are found in the ridges of Eocene limestone, but they may contain an appreciable quantity of gypsum and, if so, would be unsuitable. Yellowish clayey bands occur interbedded with the Jurassic limestone but at such distance from the coast as probably to prohibit their use in cement manufacture. There is, however, a possibility of fairly pure, whitish clay shales existing in the Coastal Limestone Series, and, in the near future, efforts will be directed to the discovery of such materials.

As regards supplies of fuel, sub-bituminous coal has been found about 15 miles south of Ankor, a native coastal port about 90 miles east of Berbera. Analyses of the coal have shown it to be of fair quality, and steps are now being taken to determine whether it occurs in commercial quantities. Should this prove to be the case the fuel required for cement manufacture would be readily obtainable at small cost. A similar coal from a locality 30 miles south of Karam and 53 miles east of Berbera was examined at the Imperial Institute a few years ago (see this BULLETIN, 1915, **13**, 189).

From the above data it is evident that it will be neces-

sary to make a careful survey of the raw materials available in the Protectorate, and to carry out analyses and technical trials with representative samples before any definite statement can be made as to the cement-making possibilities of the country.

Uganda

As the imports into Uganda are not recorded separately but are combined with those of Kenya (see next page), no figures are available showing the quantity of cement consumed in the country.

So far as can be ascertained, no deposit of high-grade limestone, of sufficient size to justify the erection of a modern rotary cement plant, has yet been located in Uganda.

For some time past building lime has been made by the Public Works Department in the vicinity of Tororo, in the Eastern Province. The quality is irregular as the material is contaminated with varying amounts of spinelid minerals, mica and other metamorphic products.

The supply at the moment is large, but as the best material is that which has been redeposited in fissures and caves, the quantity available is uncertain.

The sources of raw materials which might possibly serve for making cement on a small scale for local use were investigated by the Government Geologist during 1920. He considers it probable that hydraulic lime could be made from certain calcareous materials found in Uganda which are not of sufficiently high grade to permit of their use in the manufacture of Portland cement. Amongst such materials the following may be mentioned.

Impure nodular limestone concretions in the red earth are not uncommon; a specimen from Kiwenda gave 38 per cent. of calcium carbonate, the residue being clay and sand. A sample taken from an ancient terrace near the Kazinga Channel contained 53 per cent. of calcium carbonate. Very extensive deposits of calcareous tuffs of volcanic origin have been located along the Edward-George Rift, and have been traced as far north as Fort Portal. A specimen examined from the latter locality consisted of about 52 per cent. of calcium carbonate together with fine

clay, hydrous aluminium silicates, a little free quartz and other minerals.

It seems evident that these materials are worth small-scale technical trials in order to ascertain the quality of the hydraulic lime they would yield and the best conditions for working.

Kenya

The quantity of cement imported into Kenya and Uganda during recent years is shown in the following table[1]:

	1920. Tons.	1921. Tons.	1922. Tons.	1923. Tons
United Kingdom	5,382	2,378	7,912	11,165
India	79	5	4	—
Belgium	83	117	39	—
France	18	—	23	—
Germany	—	11	25	263
Italy	61	—	162	124
Norway	335	134	335	—
	5,958	2,645	8,500	11,552

The value of these imports amounted to £67,036, £20,865, £61,774 and £50,524 respectively.

The quantities of cement imported for home consumption during the years 1922 and 1923 were 3,483 and 4,228 tons respectively.

The question of the production of cement from local raw materials has received consideration in the Colony but it appears that the absence of local fuel suitable for cement-burning has so far prevented the manufacture from being started. It has been suggested, however, that the necessary fuel in the form of Natal coal or crude oil should be imported. Possibly the coal found in Tanganyika Territory might be used.

Coastal Deposit

The southern portion of the Island of Mombasa is composed chiefly of limestone which extends along the shores of the estuaries and runs some distance north of

[1] The figures for 1920 are for the year ending 31st March 1921; those for 1921 are for the 9 months ending 31st December, and those for 1922 and 1923 for the complete calendar year.

Mombasa. The deposit reappears in railway cuttings between Makupa bridge and Kilindini.

Samples of grey limestone and Jurassic shales which had been obtained from the east flank of the coastal range on the mainland opposite Makupa were forwarded to the Imperial Institute in 1918 by the Commissioner of Mines, in order that their suitability for cement-making might be ascertained.

The limestone, which was moderately hard and compact, contained some mud and fine quartz.

Three samples of shale were forwarded, one of which (No. 1) consisted of buff-coloured plastic clay containing a small amount of quartz sand; the other two (Nos. 2 and 3) were buff-coloured shales with some quartz and a little calcareous matter.

The limestone and shales were analysed at the Institute with the following results:

		Limestone. Per cent.	Shale No. 1. Per cent.	Shale No. 2. Per cent.	Shale No. 3. Per cent.
Silica (free)	SiO_2	7·18	33·60	34·22	34·64
Silica (combined)	SiO_2	2·72	25·10	23·03	22·28
Alumina	Al_2O_3	2·21	16·19	13·22	14·31
Ferric oxide	Fe_2O_3	1·27	4·74	5·81	7·48
Titanium dioxide	TiO_2	trace	1·07	1·43	1·08
Manganous oxide	MnO	*	trace	0·74	0·06
Lime	CaO	47·14	0·91	3·91	3·14
Magnesia	MgO	1·29	1·65	2·32	2·55
Soda	Na_2O	*	2·38	0·82	0·98
Potash	K_2O	*	1·30	3·32	2·18
Sulphuric anhydride	SO_3	0·27	0·77	0·24	0·18
Phosphoric anhydride	P_2O_5	0·44	0·04	0·30	0·27
Loss on ignition		38·20	13·38	10·89	11·23

* *Not determined.*

The analyses show that the three samples of shale were similar in chemical composition. They were all soft and easily ground, and equally suitable for cement manufacture. No constituents likely to affect adversely the finished cement were present in the limestone in appreciable quantities.

In order to manufacture a satisfactory Portland cement, the limestone would have to be mixed with the shale in the proportion of about 8 to 1 by weight. The free silica (quartz) in the materials would necessitate grinding to sufficient fineness to ensure its combination

with the lime on burning. In view of the close texture and low porosity of the limestone the material could probably be ground as obtained from the quarry, thus avoiding the cost of preliminary drying.

In order to ascertain if the materials could be satisfactorily used for cement-making, burning trials were carried out at the Institute. The limestone was mixed with shale No. 1 in the proportion of 8·22 to 1 by weight and the mixture finely ground. After moulding into a suitable form the mixture was burnt in an experimental kiln. The resulting clinker, after the addition of a small quantity of gypsum to adjust the setting time, was finely ground in a ball mill, and a cement of normal colour was obtained.

A chemical analysis and physical tests were carried out on the ground cement and the results of the former were as follows:

		Per cent.
Silica	SiO_2	23·90
Insoluble residue		1·05
Ferric oxide	Fe_2O_3	2·19
Titanium dioxide	TiO_2	0·25
Alumina	Al_2O_3	6·14
Lime	CaO	62·98
Magnesia	MgO	1·56
Potash	K_2O	0·10
Soda	Na_2O	0·34
Phosphoric anhydride	P_2O_5	0·18
Sulphuric anhydride	SO_3	trace
Loss on ignition		1·31

As regards chemical composition the cement fully satisfies the requirements of the British standard specification.

The results of the physical tests were as follows:

Fineness.—A residue of 3·8 per cent. was left on a sieve having 32,400 meshes per sq. in., and only 0·3 per cent. on a sieve having 5,776 meshes per sq. in.

Average Tensile Strength.—The figures obtained for neat cement and a mixture of sand and cement were:

	Neat cement.	3 parts standard sand to 1 part cement.
7 days test	548 lb.	260 lb.
28 days test	622 lb.	327 lb.

The cement had a specific gravity of 3·12 and an expansion of only 0·5 mm. under the Le Chatelier test.

Time of Setting.—The initial setting time was 20 mins. and the final setting time 2 hrs. 5 mins.

The cement satisfied all the requirements of the British Standard Specification for artificial Portland cement as regards physical properties.

The limestone used in the above cement-making trials was also examined as regards its suitability for making hydraulic lime. The quantity of the limestone available after the completion of the cement-making trials was however only sufficient for preliminary tests.

The chemical analysis (p. 438) shows that the limestone, considered as a possible source of hydraulic lime, contains a rather large excess of lime (CaO), and that on this account the product would not be likely to be strongly hydraulic. The hydraulic lime produced by burning the limestone is in fact somewhat similar in composition to English blue lias lime, such as Aberthaw hydraulic lime. The composition of these limes, together with that of Tiel lime from France, is given in the following table :

		1 Hydraulic lime from East African limestone	2 Aberthaw hydraulic lime	3 Tiel hydraulic lime
		Per cent	*Per cent*	*Per cent*
Lime	CaO	76·25	77·29	68·55
Alumina	Al_2O_3	3·13	1·92	4·24
Ferric oxide	Fe_2O_3	1·47	3·22	trace
Magnesia	MgO	1·62	1·52	0·52
Carbon dioxide	CO_2	0·21	—	—
Sulphuric anhydride	SO_3	0·30	—	—
Phosphoric anhydride	P_2O_5	0·55	—	—
Silica (combined)	SiO_2	15·00	16·05	26·69
Matter insoluble in hydrochloric acid		0·40		
Moisture and combined water	H_2O	1·07	—	—

The above analyses represent the hydraulic limes before slaking.

In the technical trials carried out at the Imperial Institute, the following two methods were adopted :

(*a*) The limestone was burnt for 5 to 6 hours at a temperature of about 1,200° to 1,250° C., after which it was ground to a coarse powder and left to slake under damp sand for 6 days. The product thus obtained, when ground in a mortar mill and incorporated with sand in the ordinary way, would give a hydraulic mortar of very fair strength.

Owing, however, to the excess of lime in the limestone, and the somewhat high temperature necessary in burning, care would have to be taken to ensure that the product was thoroughly slaked before use.

A pat of mortar made from a mixture of the lime, produced as described above, and an equal volume of sand, was tested as regards expansion by being subjected to a boiling test, which it passed satisfactorily, the mortar being found to be constant in volume.

(*b*) In the second series of trials the limestone was burnt for about 5 hours at a temperature of about 1,100° C. In this case the product obtained contained a higher proportion of free lime and developed considerable heat whilst slaking. It would be possible therefore to slake it in lump form, i.e. omitting the preliminary grinding, and relying upon the final mix in the mortar mill to complete the slaking of any harder burnt portions which had escaped hydration in the lump. The strength of such a lime would be much below that of a lime burnt at a higher temperature.

The trials carried out at the Imperial Institute indicate that a fairly wide range of treatment is possible in producing a hydraulic lime from this Kenya limestone. The product is of fair quality although inferior to the best hydraulic lime.

In view of the scarcity of suitable fuel in East Africa, an attempt was made to obtain a useful product by burning the limestone at a lower temperature than would be required for the production of true hydraulic lime, and using the product thus obtained as a basis for the manufacture of other hydraulic materials.

Feebly hydraulic limes are utilised in the manufacture of the product known as "Scott's cement," "Selenitic lime," or "Selenitic cement," which is used chiefly for interior work. This material is obtained by treating a somewhat hydraulic lime before slaking with a small percentage of gypsum or plaster of Paris, the addition of which greatly improves the strength; limes requiring more than 7 per cent. of gypsum are unsuitable for the treatment. Pure limes and those possessing strong hydraulic properties are unsuitable for this process, but a lime such as that produced from the present Kenya

limestone would be well suited for conversion into a selenitic lime.

In preparing selenitic lime at the Imperial Institute from the East African limestone burnt at about 1,100° C. as described above, an addition of 5 per cent. of plaster of Paris was made to the unslaked lime, and the whole was then ground to a fine powder.

The setting time of the Kenya hydraulic lime was altered considerably by this procedure; the untreated material after being slaked set in about ¾ hour, whereas after the addition of the plaster of Paris the initial setting time was reduced to 10 minutes, and in half an hour the sample had hardened sufficiently to resist the pressure of the finger nail.

It is evident from these preliminary trials that this limestone could be used for the production of a hydraulic lime of fair quality, which could be employed for making Scott's (or selenitic) cement.

Makindu Deposit

In certain districts in Kenya where there are superficial deposits of red earth, formed by the decomposition of the gneiss, there frequently occur, at a depth of a few feet from the surface, accumulations of limestone nodules known as "kankar." Such material is usually rather erratic in its distribution but in some localities the nodules have become cemented together to form a bed of limestone.

Such limestones occur near the Makindu station on the Uganda railway, and samples of white and reddish-brown varieties were analysed at the Imperial Institute in 1905 with the following results:

		White limestone. *Per cent.*	Reddish-brown limestone. *Per cent.*
Lime	CaO	48·72	47·50
Magnesia	MgO	*	2·90
Ferric oxide	Fe_2O_3	0·17	2·58
Alumina	Al_2O_3	0·44	3·00
Phosphoric anhydride	P_2O_5	trace	0·59
Insoluble residue		11·54	7·63
Loss on ignition		39·08	36·05

* *Not determined.*

Cement-making trials were not carried out on these

materials, but the white limestone should be suitable, in conjunction with a clay or shale of good quality, for use in the manufacture of Portland cement. The reddish-brown limestone contains too much magnesia for it to be used for making cement which would conform to the requirements of the British Standard Specification.

Preliminary trials at the Imperial Institute indicated that the reddish-brown limestone could be used for making hydraulic lime.

Pisolitic limestones interbedded with shales have been observed on the flanks of the gorge of the Mwachi River, between miles 11 and 12 on the Uganda railway. At some points beds of hard compact limestone 8 to 10 ft. thick occur, and these yield a fat lime on burning.

Other Deposits

In the Northern Frontier district there occur the Eil Wak sediments which comprise cream-coloured earthy limestones passing into calcareous sandstones. It is possible that material from some parts of the deposit could be used as a source of hydraulic lime. At Archer's Post a freshwater limestone occurs which attains a thickness of 100 ft.

In addition to the deposits of limestone in Kenya, consideration might also be given to the possibility of utilising coral as a source of lime, as is done in the Philippines. Numerous coral outcrops are stated to occur near the mouth of the Serrawe at Takunga and between Roka and the coast at M'Shaka. About 11 miles from Malindi coral occurs around the town of Watamu. It has also been recorded as occurring from Kipini on the coast to Witu, a distance of 15 miles. It may be mentioned that lime is produced on Patta Island, in Mander Bay and at Tundwa, and that coral rocks are reported from the headlands between Port Durnford and Shakau.

TANGANYIKA TERRITORY

The quantities of cement imported into Tanganyika during 1921 and 1922 amounted to 1,744 and 4,199 tons respectively; practically the whole of this was used locally.

In the Uluguru, Livingstone and Pongwe mountains, crystalline metamorphic limestones occur associated with gneisses, but these are frequently dolomitic and contain secondary silicates and would therefore probably be unsuitable for use in the manufacture of Portland cement.

A more promising region, however, is the coastal belt where there are numerous occurrences of marine limestones of varying geological age.

According to the *Final Report of the Geological Survey of Tanganyika Territory*, much of this coastal limestone could be used for lime-burning and some might be suitable for use in cement-making. A sample of hard fossiliferous Jurassic limestone from the Rest House Hill north of Kidugallo railway station, according to the above Report, gave the following results on chemical analysis :

		Per cent.
Lime	CaO	35·10
Magnesia	MgO	2·00
Ferric oxide / Alumina	Fe_2O_3 / Al_2O_3	0·48
Phosphoric anhydride	P_2O_5	1·82
Silica	SiO_2	18·32
Insoluble matter (not silica)		10·82

It is evident that the quantity of magnesia (and probably silica) would be too high and the lime too low to permit of this material being mixed with a clay or shale for the production of Portland cement, but it is possible that admixture with limestone of better quality might be effectual for this purpose. It is possible also that it might give a natural cement, but a series of carefully conducted technical trials would be necessary in order to determine this point.

Dr. E. O. Teale in the above Final Report states that extensive and massive white crystalline limestones are noteworthy features in several areas of Tanganyika, particularly in (1) the Umba Steppe about 20 miles north-west of Moa ; (2) the Handeni district which lies about 40 to 50 miles from Korogwe, and (3) the eastern Uluguru region within easy distance of the central railway.

In some occurrences the rock is a white marble, whilst in others scales of graphite and other minerals occur.

It is possible that many of these limestones could be

used for the production of cement or hydraulic lime, but it is difficult to form an opinion in the absence of the results of chemical analyses and technical trials.

Should the question of producing cement in Tanganyika Territory be considered seriously it is probable that a suitable coal for burning the materials could be found in the country.

Zanzibar

There is a small and apparently increasing demand for Portland cement on the Island. The quantities imported during 1921 and 1922 were 757 and 2,474 tons respectively.

According to a report furnished by the Director of the Geological Survey of Uganda, there is a plentiful supply of massive coral suitable for use in the manufacture of Portland cement. Septarian nodules (cement stone) occur in a formation at Chaki Chaki in Pemba and the latter would doubtless be suitable for use without admixture with other material, but good fuel is scarce and expensive.

In view of the small local demand for cement and the high cost of fuel, it does not seem likely that the manufacture of cement or hydraulic lime could be undertaken profitably in Zanzibar in the immediate future.

Nyasaland

The cement imported into Nyasaland for home consumption during 1922, the last year for which figures are available, amounted to 244 tons, of value £1,537, obtained from the following sources: United Kingdom, 122 tons; Union of South Africa, 39 tons; Portuguese East Africa, 50 tons; Germany, 33 tons.

Much valuable information, regarding cement-making materials and other economic minerals occurring in Nyasaland, was accumulated during the course of the Mineral Survey of Nyasaland which was conducted in connection with the Imperial Institute by A. R. Andrew, M.Sc., F.G.S., and T. E. G. Bailey, B.A., F.G.S., during 1906–9. The mineralogical work has been summarised in "Reports on the Results of the Mineral Survey" (of Nyasaland), which were published in the Miscellaneous Series of Colonial Reports (Cd. 3916, 4908 and 5900). The

geological aspect was discussed by the Surveyors in *Quart. Journ. Geol. Soc.* (1910, **66**, 189–237).

It may be pointed out that good supplies of coal were discovered by the Officers of the Mineral Survey in certain localities on the shores of Lake Nyasa, near which occur some of the limestones described later.

Since the termination of the Mineral Survey the Institute has carried out analyses and technical trials on a number of other samples of cement-making materials received through official sources in Nyasaland. The reports on certain of these are summarised in the following pages, together with information available from other sources.

North Nyasa, M'pata District

The occurrence of limestone in this district was recorded by the Mineral Surveyors in 1907 and samples received at the Imperial Institute were submitted to analysis.

In 1921 a further series collected by the Government Geologist were sent to the Institute by the Chief Secretary in order that their suitability for cement-making might be ascertained.

According to Andrew and Bailey, the M'pata district covers an area of about 15 square miles south of the Rukuru River in the north-east part of the Protectorate. The limestones occur in the Karoo deposits, which lie in a broad valley-like depression, and are bounded on three sides by lines of fault. The calcareous group, which is at least 700 ft. thick, comprises mudstones, interbedded with thinly-bedded argillaceous and oolitic limestones. Certain limestones in this area are now burnt for the production of lime for building purposes.

The limestones received in 1921 for analysis and technical trial were as follows:

"No. 27." The sample consisted of a recent concretionary crystalline limestone of buff colour.

"No. 28." This was a compact, massive grey limestone containing much sandy and clayey impurity.

"No. 29." The sample generally resembled the preceding limestone (No. 28), but was more compact.

"No. 30." This material consisted of a compact

massive grey limestone, very similar in appearance to No. 29.

"Sample 31." This was a compact yellowish limestone containing much siliceous and argillaceous impurity.

"Sample 32." A compact siliceous limestone of a light yellowish-grey colour.

"Sample 33." This specimen consisted of a compact flinty limestone of a light grey colour.

Chemical analyses of these limestones gave the following results:

		27. Per cent.	28. Per cent.	29. Per cent.	30. Per cent.	31. Per cent.	32. Per cent.	33. Per cent.
Lime	CaO	54·02	39·16	45·38	45·38	33·58	33·53	36·24
Magnesia	MgO	0·32	1·57	1·35	0·96	1·38	1·63	1·30
Alumina	Al_2O_3	0·90	4·79	3·71	1·59	6·76	3·18	3·02
Ferric oxide	Fe_2O_3	0·16	1·53	0·58	0·97	1·21	2·74	1·77
Titanium dioxide	TiO_2	trace	0·18	0·11	0·11	0·24	0·28	0·19
Sulphuric anhydride	SO_3	0·03	0·12	0·10	0·13	0·04	0·07	0·10
Phosphoric anhydride	P_2O_5	0·02	0·19	0·16	0·17	0·13	0·11	0·15
Silica, free	SiO_2	1·62	10·31	5·70	7·48	19·48	22·69	21·94
Silica, combined	SiO_2		8·60	4·44	4·64	6·32	6·20	4·49
Loss on ignition	.	42·98	33·09	37·48	37·64	28·76	29·07	30·07

Materials for Portland Cement.—The analysis of No. 27 shows that it represents limestone of good quality which would be well adapted for use in the manufacture of Portland cement if combined with a suitable clay or shale.

By mixing 1·7 parts of limestone No. 28 with 1 part of limestone No. 29, finely grinding and then burning at a suitable temperature, a Portland cement was obtained which had the following chemical composition:

		Per cent.
Lime	CaO	64·10
Magnesia	MgO	2·30
Alumina	Al_2O_3	6·80
Ferric oxide	Fe_2O_3	1·80
Titanium dioxide	TiO_2	0·23
Sulphuric anhydride	SO_3	0·17
Phosphoric anhydride	P_2O_5	0·29
Silica	SiO_2	24·20

This cement complied with the requirements of the British Standard Specification as regards chemical composition.

The quantity of the raw materials received did not permit of sufficient cement being produced for a full series of physical tests to be made, but it was found that the

cement was somewhat slow-setting, perfectly sound in water and air and showed a good progressive increase in strength between 7 and 28 days after gauging.

The use of the two limestones Nos. 28 and 29 for the manufacture of Portland cement should not involve any serious technical difficulties. The silica present is in a fine state of division, and extremely fine grinding would not be required.

Materials for Natural Cement.—The analysis of sample No. 28 indicates that this limestone, in addition to being suitable for the manufacture of Portland cement by combination with a suitable quantity of limestone No. 29, could probably be used for the production of "natural" cement by simple burning and grinding. The sample was insufficient for complete technical trials, but preliminary tests were made, the results of which are summarised below.

The limestone was burnt, without grinding, at a temperature of about 1,000° C. for 8 hours. The natural cement thus produced, after being finely ground, had an initial setting time of about 10 minutes and a final setting time of about 1 hour.

The chemical composition of the natural cement was as follows:

		Per cent.
Lime	CaO	55·43
Magnesia	MgO	2·12
Alumina	Al_2O_3	7·67
Ferric oxide	Fe_2O_3	
Titanium dioxide	TiO_2	1·69
Sulphuric anhydride	SO_3	0·08
Phosphoric anhydride	P_2O_5	0·26
Silica, combined	SiO_2	30·14
Silica, free	SiO_2	1·00
Loss on ignition		1·39

Pats made from the cement hardened somewhat slowly but satisfactorily both in air and water and were constant in volume.

Natural cement made from this limestone would probably have a greater tensile strength than that which could be produced from Sample No. 6 from N'tundu River (see p. 454), or from limestones Nos. 31, 32 or 33. Further trials on a larger scale would, however, be necessary to determine this point.

The chemical analyses show that limestones Nos.

31, 32 and 33 all contain too much silica to permit of their use in the manufacture of Portland cement or of hydraulic lime of good quality. The limestones would not yield a good natural cement, but trial burnings were carried out with the three materials in order to determine if a product of fair quality could be obtained. The details of these trials, the conditions of which were varied to suit each particular sample, were as follows.

No. 31 was burnt for 20 hours at 900° C.; No. 32 was burnt for 6 hours at 900° C., and No. 33 for 20 hours at 950° C.

After being finely ground and gauged with water the burnt materials all behaved somewhat similarly as regards their setting and hardening properties. All three had initial setting times of about 15 minutes, and set hard in 1 to 1½ hours. Tests showed that the cements after gauging were of constant volume.

The quantity of material available did not permit of a full series of tests being made, but the following results of the tensile tests of the neat cement briquettes will be of interest:

		No. 31.	No. 32.	No. 33.
14 days after gauging .	*lb. per sq. inch*	30	not determined	43
28 days after gauging .	*lb. per sq. inch*	43	113	72

It was found that the addition of about 1 per cent. of plaster of Paris to the cement prepared from limestone No. 33 increased the strength of the briquettes at 14 and 28 days to 70 and 129 lb. respectively without adversely affecting the soundness of the cement.

The above results show that only poor grades of natural cement could be produced from any of these three limestones, but they could, no doubt, be used locally in the absence of better materials. Nos. 32 and 33 give cements which approximate in strength to the poorest class of American natural cements now made.

Materials for Hydraulic Lime.—A consideration of the chemical analysis of sample No. 29 and the physical condition of the limestone indicated that it could be used either in conjunction with No. 28 for the manufacture of Portland cement (see p. 447), or alone for the production of hydraulic lime.

In order to determine its suitability for the preparation of hydraulic lime, the limestone was broken into pieces, approximately 1 cubic inch in size, and these were burnt at a temperature of about 1,100° C. for 8 hours. The burnt product gave the following results on analysis :

		Per cent.
Lime	CaO	68·90
Magnesia	MgO	2·20
Alumina	Al_2O_3	3·66
Ferric oxide	Fe_2O_3	1·00
Sulphuric anhydride	SO_3	0·31
Silica, free	SiO_2	2·69
Silica, combined	SiO_2	14·29
Loss on ignition		5·05

The hydraulic lime thus produced was finely ground, mixed with an equal volume of damp sand, and left to slake for 24 hours. Sufficient water was then added to make a plastic mortar. Briquettes made from this mixture were stored in damp air for 7 days and then in water, and their tensile strength was determined at 28 days and 3 and 6 months after gauging. The results obtained, in comparison with those yielded by commercial "blue lias hydraulic lime" under the same conditions, were as follows :

	Hydraulic lime from Sample No. 29. *lb. per sq. inch.*	Blue lias hydraulic lime. *lb. per sq. inch.*
At 28 days .	143	150
At 3 months .	242	258
At 6 months .	279	280

The above results show that a good hydraulic lime would be obtainable from material represented by the present sample.

A hydraulic lime was prepared at the Imperial Institute by burning limestone No. 30 broken into pieces approximately 1 cubic inch in size, at a temperature of 1,000° C. for 8 hours. The burnt product was analysed with the following results :

		Per cent.
Lime	CaO	69·42
Magnesia	MgO	1·54
Alumina	Al_2O_3	2·23
Ferric oxide	Fe_2O_3	0·69
Sulphuric anhydride	SO_3	0·16
Silica, free	SiO_2	3·88
Silica, combined	SiO_2	12·54
Loss on ignition		9·25

Briquettes made from this hydraulic lime, after being gauged and treated as described on p. 450, developed the following tensile strengths :

	lb. per sq. inch.
At 28 days . . .	123
At 3 months . .	187
At 6 months . .	214

The above results indicate that sample No. 30 would probably prove somewhat inferior to No. 29 for the production of hydraulic lime. It would, however, be desirable to have further technical trials carried out.

Hydraulic limes were also made from the three limestones Nos. 31, 32 and 33 by burning them under the following conditions, which were varied in each case to suit the sample :

No. 31 was burnt for 12 hours at a temperature of 950–1,000° C.
No. 32 was burnt for 10 hours at a temperature of 800–850° C.
No. 33 was burnt for 15 hours at a temperature of 950° C.

The finely-ground products were slaked for 24 hours and then gauged into briquettes and pats which were stored in damp air for 14 days and afterwards immersed in water for the remainder of the period of trial. The results of the tensile tests as compared with those given by a commercial sample of "blue lias hydraulic lime" under the same conditions, were as follows :

		No. 31.	No. 32.	No. 33.	Blue lias hydraulic lime.
At 28 days .	lb. per sq. inch	70	42	100	285
At 3 months	lb. per sq. inch	235	257	278	329

The increase in strength between 28 days and 3 months is noteworthy, as the materials at the later date had attained a strength approaching that developed by good quality "blue lias hydraulic lime."

N'Kana District

In the N'Kana district in the northern part of Nyasaland, numerous occurrences of coal and limestones have

been found in the Karoo Series. According to a report made by the Principal Mineral Surveyor, there occurs in the sedimentary rocks, overlying the gneiss, a calcareous series 145 feet thick containing 34 ft. of argillaceous limestones, with which are interbedded green shales and yellow marls. None of the individual limestone beds is more than 5 ft. in thickness. The limestone series forms a line of hills rising about 100 feet above the Makeya Valley and running north and south for a distance of 5 or 6 miles. The results of chemical analyses made at the Imperial Institute on 14 samples from the various beds of limestone in the Series will be found in *Report on Results of the Mineral Survey*, 1907–8, pp. 29–31 (Cd. 4908). These analyses show that there is considerable variation in the composition of the beds. Most of the latter are marly in character and contain a fairly large amount of silica, whilst others are dolomitic. Preliminary technical trials at the Institute showed that several of the limestones were promising raw materials for the manufacture of hydraulic lime. Unfortunately the samples sent were insufficient for a complete series of burning trials to be made.

Upper Shire District

In 1906 the Surveyors recorded that among the metamorphic rocks between Zomba and Chirobwe there was a noteworthy band of crystalline limestone showing a thickness of 1,500 ft. near Chenkumbi Hill, Liwonde, and traceable for a distance of 30 miles to the north-west. They also reported two outcrops of similar limestone on a road running along the west bank of the Lisungwe River which probably represents the S.W. extension of the deposit.

It was suggested that this limestone could be used, in conjunction with the mud from the Shire River near Liwonde, for the preparation of Portland cement.

A further sample of 40 lb. of the limestone was forwarded to the Imperial Institute by the Chief Secretary in January, 1921.

This was a sample of white, crystalline, dolomitic limestone containing only small amounts of siliceous impurities. On analysis it gave the following results :—

		Per cent.
Lime	CaO	49·41
Magnesia	MgO	5·15
Alumina	Al_2O_3	0·81
Ferric oxide	Fe_2O_3	0·18
Titanium dioxide	TiO_2	trace
Sulphuric anhydride	SO_3	0·24
Phosphoric anhydride	P_2O_5	trace
Silica	SiO_2	1·48
Loss on ignition		42·72

This limestone contains too much magnesia to permit of its use in the manufacture of Portland cement, and it would not yield a natural cement or hydraulic lime on burning. It has been used locally for lime burning. In view of the extent of the occurrence it seems desirable that samples should be examined from other parts of the deposit in order to ascertain whether any limestone suitable for cement-making is present.

Lower Shire District

A number of limestones and clays from the Lower Shire district were collected by the Government Geologist and sent to the Imperial Institute in 1919 for examination.

The limestone samples were as follows :

No. 1 was a crystalline dolomite from near the Anglo-Portuguese border about 7½ miles from Port Herald, and on the crest of the ridge forming the left bank of the Chididi stream.

The outcrop has been traced for a distance of 600 yards and is about 100 ft. thick, but probably only from 10 to 15 ft. would be worth quarrying.

No. 2 was a crystalline limestone from an outcrop on the right bank of the Chimiara stream, about 800 feet above the plain and 1½ miles from the railway. The outcrop has been traced for 200 yards, the bed is at least 20 ft. thick but impure. The limestone could be easily quarried.

No. 3 was a crystalline limestone taken about half a mile south of Makoko's village, on a low ridge between the Nyankotola and Nachipere rivers. The limestone is 30 ft. thick but is impure. It is well situated for quarrying.

No. 4 was a crystalline dolomite from a dry stream bed 1 mile N.E. of Lulwe Mission. The outcrop has been

traced for a distance of 1 mile. A thickness of 70 ft. could be quarried.

No. 5 was a crystalline dolomite taken from the bed of the Nachirenda river at the N.E. end of Mwima Hill. A thickness of 15 to 20 feet is available.

No. 6 was a concretionary limestone from the bed of the N'tundu river between Damera village and the railway bridge. This is stated to be the only considerable occurrence of recent limestone in the Lower Shire district.

The clays accompanying the limestones were as follows:

No. 7. Matope mud of Shire, Port Herald.

No. 8. Alluvium of the N'tundu river.

No. 9. A calcareous clay (with some coarse quartz fragments) from the railway 20 miles from Port Herald.

Chemical analyses of the limestones and clays gave the following results:

		1. Per cent.	2. Per cent.	3. Per cent.	4. Per cent.	5. Per cent.	6. Per cent.	7. Per cent.	8. Per cent.	9. Per cent.
Lime	CaO	31·42	47·23	38·97	31·82	31·13	30·93	3·63	3·53	14·34
Magnesia	MgO	19·94	5·64	11·62	20·32	20·28	2·16	2·10	2·01	5·25
Alumina	Al_2O_3	0·72	0·98	2·02	0·41	0·68	6·12	16·44	13·94	16·38
Titanium dioxide	TiO_2	*	*	*	*	0·06	0·61	0·96	1·40	*
Ferric oxide	Fe_2O_3	0·68	0·08	0·16	0·07	0·65	3·91	7·44	6·58	3·65
Silica	SiO_2	1·76	3·76	9·23	1·04	2·19	26·67	56·98	57·89	41·17
Loss on ignition	H_2O, CO_2	44·96	42·11	37·69	45·86	44·71	27·88	6·69	7·22	17·68
Potash	K_2O	*	*	*	*	*	*	1·26	3·46	*
Soda	Na_2O	*	*	*	*	*	*	4·46	4·02	*

* *Not determined.*

Materials for Portland Cement.—All the above limestones from the Lower Shire district, except possibly No. 6, contain too large an amount of magnesia to permit of their being used in the manufacture of a Portland cement which would conform to the requirements of the British, United States or German Standard Specifications. No. 6 might perhaps be used in conjunction with a less siliceous limestone.

The amount of coarse sand present in clays Nos. 7 and 8 is too large to make such clays particularly suitable for use in cement-making.

Technical trials made at the Imperial Institute showed

that it would be possible however to make a cement of the Portland type from a mixture of 4 parts of limestone No. 2 from Chimiara and one part clay No. 8 from N'tundu River.

The cement had the following chemical composition:

		Per cent.
Silica	SiO_2	20·58
Insoluble residue		1·33
Ferric oxide	Fe_2O_3	2·17
Alumina	Al_2O_3	6·43
Lime	CaO	60·95
Magnesia	MgO	6·74
Sulphuric anhydride	SO_3	1·06
Loss on ignition		0·66

The cement, when ground so as to leave a residue of 11 per cent. on a sieve having 160 meshes per linear inch, had initial and final setting times of 140 minutes and 330 minutes respectively. It was quite sound under the Le Chatelier test. The average tensile strength of the neat cement, when gauged with 23 per cent. of water, tested at 7 and 28 days after gauging was 705 and 797 lb. per square inch respectively. It is evident therefore that a fairly strong cement could be made from these materials.

Materials for Natural Cement.—Chemical analyses showed that none of the materials, except possibly No. 6, would be suitable for burning to natural cement.

Technical trials carried out at the Institute showed that the natural cement obtainable from this material had only feebly hydraulic properties owing to the fact that the quantity of lime present was insufficient to combine with the silica, and that the latter was present, in part at least, as coarse fragments of quartz.

Materials for Hydraulic Lime.—None of the samples from the Lower Shire district was found to be suitable for this purpose alone, but trials carried out at the Institute showed that an artificial hydraulic lime, comparable to ordinary English hydraulic lime, could be made by combining about 5·5 parts of limestone No. 3 with one part of the calcareous clay No. 9 and burning at a temperature of 1,200° C. It is probable, however, that the preparation of such a lime would be too costly owing to the amount of grinding required.

Central Angoniland

Crystalline limestone occurs on both sides of Mtuma mountain, and to the south near Paundi's village it occurs with much siliceous impurity in beds over 50 feet thick.

According to Andrew and Bailey, the eastern portion of Central Angoniland is characterised by a group of rocks consisting of graphitic gneisses interbanded with felspathic gneiss, thick beds of crystalline limestone and kyanite schists. The limestones, which are generally impure, can be traced southwards for a considerable distance down the Shire valley and are again met with in the Port Herald district.

Zomba

One of the most promising limestones for the manufacture of Portland cement received from Nyasaland was that from Shirwa Island in Zomba Province. It was forwarded to the Imperial Institute in 1908 in order that it might be tested for cement-making, in conjunction with sand from the "dambos" near Zomba, or with a brick earth found near Zomba mountain.

Chemical analysis of the raw materials gave the following results:

		Shirwa limestone. *Per cent.*	Brick earth. *Per cent.*	Dambo sand. *Per cent.*
Lime	CaO	55 7	trace	0·90
Magnesia	MgO	—	—	trace
Ferric oxide	Fe_2O_3	0·25	13·00	2·48
Alumina	Al_2O_3		22·68	19·80
Silica	SiO_2	0·29	55·70	70·30
Loss on ignition		—	—	5·58

Although the limestone was of excellent quality, the Dambo sand and the brick earth were very unsatisfactory as regards physical condition, as both contained much coarse free quartz.

Cement-making trials were carried out at the Institute in 1908 using varying proportions of the three materials, but the Portland cement produced was of poor quality, owing to the difficulty of securing the siliceous matter in a sufficiently fine condition.

Fort Johnston

In 1906 it was observed by the Mineral Surveyors that several outcrops of crystalline limestone, apparently of considerable extent, occurred in the hills on the west side of Fort Johnston. In 1920, samples of a greyish-white crystalline limestone and a buff sandy clay from Fort Johnston were received at the Institute for investigation as cement-making materials.

Chemical analyses of these raw materials gave the following results:

		Limestone. Per cent.	Clay. Per cent.
Lime	CaO	52·89	1·99
Magnesia	MgO	1·84	0·75
Alumina	Al_2O_3	0·44	8·11
Ferric oxide	Fe_2O_3	0·24	2·12
Titanium dioxide	TiO_2	0·04	1·06
Sulphuric anhydride	SO_3	0·03	0·36
Phosphoric anhydride	P_2O_5	nil	nil
Potash	K_2O	*	2·56
Soda	Na_2O	*	1·38
Silica	SiO_2	1·80	72·55
Loss on ignition		42·20	9·15

* *Not determined.*

The above results show that the limestone is of good quality and suitable in all respects for use in making Portland cement.

The clay contained a quantity of sand chiefly composed of quartz and felspar, and was therefore much too siliceous to permit of its use in cement-making without preliminary treatment. If, however, a less siliceous clay is not available in the locality the material could be readily washed so as to remove the coarser portion of the sandy matter. Experiments made at the Imperial Institute showed that on washing a product was obtained amounting to 57 per cent. of the raw material and containing 55·0 per cent. of silica and 13·2 per cent. of alumina. Such clay would be quite suitable for use in conjunction with the above limestone for the manufacture of Portland cement conforming to the requirements of the British Standard Specification.

SOUTHERN RHODESIA

The manufacture of Portland cement has been carried on for the past ten years near Bulawayo and hence the

quantity of Portland cement imported into Southern Rhodesia is small, amounting during the years 1922 and 1923 to only 381 and 702 tons respectively.

The Premier Portland Cement Co. was incorporated in 1913 and reconstructed in 1920. Its works are situated at Cement Siding, 9 miles from Bulawayo on the main route to Gwelo, and are connected to the limestone quarries, 14 miles distant, by a narrow-gauge railway.

The raw materials used at the factory are a shale and hard blue-grey limestone, which have the following composition:

		Limestone. *Per cent.*	Shale. *Per cent.*
Lime	CaO	47·81	0·92
Magnesia	MgO	trace	2·63
Ferric oxide	Fe_2O_3	2·52	7·68
Alumina	Al_2O_3		22·42
Manganous oxide	MnO	1·24	—
Silica		9·22	58·58
Water and organic matter		1·17	6·17
Carbon dioxide	CO_2	37·57	—

The limestone, which is quarried by the bench system, occurs as an outcrop 50 to 70 ft. wide and has been traced over a distance of 2,000 ft. It is estimated that the limestone in sight will suffice for the next 10 years at the present rate of consumption.

The factory is equipped with modern plant including a rotary kiln measuring 90 ft. × 6 ft. and having a capacity of about 15,000 tons of Portland cement per annum. The cement is produced by the dry process, the fuel employed being a caking coal, containing 11 per cent. of ash, obtained from the Wankie Colliery.

According to information supplied by the Premier Portland Cement Co., Ltd., the cement produced, when tested according to the British Standard Specification, has the following tensile strength:

	At 7 days. *lb. per. sq. in.*	At 28 days. *lb. per. sq. in.*
Neat cement	656	781
Cement + 3 parts standard sand	272	353

It was stated in July 1924 that the factory was working at full capacity.

Limestone deposits are stated to occur fairly widely

distributed throughout the Colony, but usually they are of small extent.

At Lomagundi there occurs a thick series of somewhat dolomitic crystalline limestones which have been traced east and west for 30 or 40 miles. The series is well developed at Sinoia.

A deposit of limestone of some considerable extent underlies the hæmatite iron ore which occurs about five miles south of Que Que township and four miles west of the railway line. The deposit has been traced for over a mile and is several hundred yards wide; it has been proved to a depth of 80 ft.

An analysis of the limestone made at the Imperial Institute in 1918 gave the following results:

		Per cent.
Lime	CaO	52·83
Magnesia	MgO	1·62
Ferric oxide	Fe_2O_3	0·20
Alumina	Al_2O_3	0·72
Silica	SiO_2	0·40
Loss on ignition	H_2O, CO_2	44·06

Such material, which is now used for the production of building lime, would be well adapted for use in the manufacture of Portland cement.

Several deposits of limestone have been located in the basement schists of the Enterprise Mineral belt, a district situated due east of Salisbury. H. B. Maufe (*Bull. 7, Geol. Surv., S. Rhodesia*) states that these limestones are usually somewhat coarsely crystalline and of a greyish colour. Nine occurrences were recorded but all were of limited size.

The longest outcrop in this belt, which is about half a mile in length and occurs west of Sternblick farm, yields a bluish-white rock composed largely of calcite crystals. No analyses are available but, as it is stated that the limestone may be expected to yield a fat lime on calcination, it seems probable that it would be suitable for use in cement-making.

At Chishawasha five outcrops have been located, the material from two of which has been used for lime-burning. The beds dip at 65° N., 15° W., and there is exposed a

succession of 52 ft. of calcareous strata of which 36 ft. is suitable for lime-burning.

A chemical analysis of the uncalcined limestone gave the following results :

		Per cent.
Lime	CaO	55·05
Magnesia	MgO	0·10
Ferric oxide / Alumina	Fe_2O_3 / Al_2O_3	0·50
Sulphuric anhydride	SO_3	0·15
Silica	SiO_2	0·90
Carbon dioxide	CO_2	43·00

The above analysis indicates a high-grade limestone well adapted for the manufacture of Portland cement.

The material from another limestone quarry, about half a mile south of Kilmuir farm, has been used for lime-burning, but it is stated that the several bands vary considerably in quality.

In certain localities in Southern Rhodesia there occur soils containing a concretionary limestone known as "vlei" which much resembles the "kankar" found in Kenya (see p. 442). Owing to the small quantity usually available, however, the deposits would only suffice for local use.

Occasionally deposits of travertine limestone occur of sufficient size for local requirements, notably in the Selukwe mineral belt, but it is probable that the material generally contains too much magnesia for use in cement-making.

FULLER'S EARTH

In view of the enquiries that are received from time to time at the Imperial Institute regarding fuller's earth, its uses and occurrences, it has been thought desirable to publish a summary of the information available on the subject. Further details on certain points will be supplied if desired (application for which should be made to the Director, Imperial Institute), and the publications consulted in preparing the article may be seen in the library of the Institute.

General

Fuller's earth has been known from very ancient times and is the *creta cimolia* of Pliny. It may be described as a variety of porous clay having certain adsorptive properties. It absorbs grease from cloth, etc. (owing to which property it is of service to fullers) and adsorbs basic colours from animal, vegetable and mineral oils. Fuller's earth appears to carry an unusually large proportion of colloids of high adsorptive power, and its bleaching action is believed to be due to this fact. When examined under the microscope, fuller's earth is seen to be composed partly of amorphous and partly of crystalline matter—the latter includes free silica and silicates and various mineral substances, some of which are detrital. The earth is said to be honeycombed with innumerable microscopic canals that bring about an enormous increase in the adsorptive surface, and the power of adsorption is believed to be largely due to the amorphous constituents.

Chemically, fuller's earth is a mixture of hydrous aluminium silicates, containing small but varying proportions of oxides of iron, lime, magnesia, soda, potash, etc. The material is believed by some to be derived from basic igneous rocks, such as gabbro, diorite, dolerite and basalt, the characteristic mineral constituents of which are augites and hornblendes, with the felspars less conspicuous. It is noteworthy that magnesia is frequently a prominent constituent of fuller's earth, being present in much higher amount than in ordinary clays. In this connection it may be mentioned that in Saxony, fuller's earth is found *in situ* derived from gabbro, and at Fairplay, between Hot Springs and Benton, Arkansas, the residual clay from certain basic dykes (ouachitite and monchiquite) is successfully used as a fuller's earth, and is found to contain much augite and a less amount of hornblende, with practically no felspar. Residual clay from a syenite dyke in the same area has not, however, proved satisfactory as a fuller's earth, most of it having been derived from felspars, and only a small part from hornblende. Fuller's earth also occurs as an alteration-product of shale (Texas) and of killas (Cornwall).

The kinds of deposits referred to in the preceding paragraph are rare, and the principal deposits of fuller's earth occur as more or less regular beds in sedimentary rocks from Tertiary to Palæozoic in age. They are of secondary origin and appear to be the result of weathering.

Uses

The original use of fuller's earth for fulling cloth has become almost obsolete, its place having been taken by soap and other chemical detergents. Its chief use now is for removing colour from oils and fats. In the United States it is used for removing the "floc" which causes turbidity of kerosene on cooling, and for decolorising such products as vaseline, paraffin, and spindle and lubricating oils. The following or a similar method is used for refining edible oils. In the case of cotton-seed oil the crude oil must first be treated with an alkali (such as sodium hydroxide) to neutralise the free fatty acids, and to convert the colouring matter into basic forms. The oil, placed in a large vat, is heated by steam to nearly 100° C. It is then rapidly stirred by paddles and the necessary quantity of fuller's earth is added. After a few minutes the mixture is run through a filter press, by which the fuller's earth is removed. Fuller's earth is also used in the preparation of cold-water paint. Fuller's earth cake from oil mills can be used in the manufacture of hard soaps, concrete waterproofing and asphaltic preparations. In the laboratory the earth is used to detect the addition of certain colouring matters to butter, whisky and artificial vinegar. In pharmacy it is employed to some extent as a powder for allaying irritation of the skin. It is also used in the woollen industry for removing the excess of colouring matter from goods after dyeing.

Fuller's earth from different localities may vary much as regards adsorptive properties. Thus, certain deposits are suitable for decolorising vegetable oil, and others for decolorising mineral oil, and so forth. This variation, in some instances, may be largely due to the degree of temperature and mesh of the screening employed in preparing the earth for the market.

The use of fuller's earth for decolorising oil has certain

drawbacks, such as the very large quantity of it required to obtain commercial results, and the relatively large amount of oil retained by the material.

Substitutes

Several substitutes are being used or have been suggested. Bauxite is very largely used for refining petroleum distillates and for decolorising wax derived from petroleum, but it is not so efficient when applied to shale products. Silica gel is being used in the refining of gasolenes and kerosenes, but it is an artificial product, and it is doubtful whether it can compete with natural clays and earths in the refining and purification of mineral oils. Bentonite appears to be suitable for the clarification of oils (see this BULLETIN, 1922, **20**, 349), and this and other colloidal clays are coming into vogue in this connection. Three deposits are at present being exploited in California. The clay of one of these, known as montmorillonite, occurs in a level stratum 3 to 7 ft. thick, in San Diego Co. It is believed to be an altered volcanic ash rather than a true clay. The deposit is said to extend for miles into Mexico. After treatment with sulphuric acid all the clay —no matter what its colour when raw—yields a filtering material of uniform value. The other clays mined are halloysite and pyrophyllite. In the raw state these clays have no decolorising or deacidifying value, but after special treatment with sulphuric acid, clays of high adsorptive value result, provided they are used in the form of powder (200 mesh). These finely-divided acid-treated clays have proved to be several times as efficient as fuller's earth, and their mining, manufacture and distribution have formed a new industry.

Production

The United Kingdom and the United States have for long been the principal producers of fuller's earth. From 1913 to 1921, inclusive, the former country produced 252,519 long tons, with 37,862 tons as the highest output in 1914, and 20,242 tons as the lowest in 1921. No official figures of output have been published since 1921.

From 1895 to 1923, inclusive, the United States produced 1,227,533 long tons of fuller's earth. In 1903, the output was 18,476 tons, whereas in 1922 it was 124,057 tons. Thus in twenty years the production has increased nearly sevenfold. This increase is largely due to the growing demand for fuller's earth in the refining of mineral oils. There has been a considerable increase in the United States production since 1915. There has also been an increase in the price, for, whereas in 1915 it was \$8·31 per short ton, in 1921 it was \$12·26. At present (August 9, 1924) the price of Florida earth, 30 to 60 mesh, is quoted at \$18, and powdered, imported, duty paid material, from \$23 to \$25 per ton.

Deposits in the British Empire

Great Britain.—In Great Britain, fuller's earth is found in several localities, and has been mined for many years. Indeed, in the seventeenth century, and early part of the eighteenth century, the export of fuller's earth was prohibited in England, but the prohibition was withdrawn in 1712.

In the Transactions of the Royal Society for 1684 is a note on fuller's earth of a yellowish colour at Brickhill in Northamptonshire, and, about 1713, there was a description of pits of fuller's earth opened at Wavendon, near Woburn, Bedfordshire. These deposits occur in the Lower Greensand (Cretaceous). In 1799, William Smith applied the term fuller's earth to certain clays in the neighbourhood of Bath, Somersetshire. The horizons of these clays have been recognised by geologists, and they form part of what is now known as the Fullonian formation lying between the Great Oolite and the Inferior Oolite (Jurassic). The series consists of upper fuller's earth clay (which is worked), fuller's earth rock (an earthy limestone, usually fossiliferous), and lower fuller's earth clay (unworked). The Fullonian formation extends from the Dorsetshire coast through Somersetshire and Gloucestershire to the neighbourhood of Chipping Norton in Oxfordshire. The greatest development of the formation is in Dorsetshire where it is 400 ft. thick; near Bath it is only 150 ft. thick.

The economic fuller's earth near Bath is a bluish, or greenish-grey clay that weathers to a brown or yellowish-brown colour ; is slightly calcareous and ferruginous, and contains small particles of magnesia, soda and potash. It is a soft dull earthy clay, having a shining streak, and is somewhat greasy to the touch. Although unctuous it is not plastic. The so-called " veins " vary from 18 in. to 5 ft. in thickness. One pit shows 3 ft. 6 in. of fuller's earth, the roof and floor consisting of rubbly rock. The fuller's earth sometimes occurs in impersistent and lenticular masses that in places attain a thickness of 5 or 6 ft. Elsewhere, it gradually passes into ordinary marl or clay. The fuller's earth mined at Midford near Bath is 4 to 7 ft. thick, and is worked by galleries driven into the hillside. Small nodules of limestone occur in the earth. The overlying beds are blue and brown marly clays with bands of nodular earthy limestone. At Coombe Hay, also near Bath, fuller's earth was worked by shafts sunk to a depth of 20 to 30 ft. The preparation of fuller's earth as conducted at Midford in 1893 was as follows: The hard earth, after being ground up with three times its own bulk of water (" slurry "), was passed into little tanks (" catch-pits ") in which the coarser particles sank to the bottom. The liquid then ran into a long earthenware drain, laid underground, which conveyed it to the works, more than half a mile distant. Here the turbid water flowed into a long shallow trough (" maggie "), the coarse particles being caught in a series of little wooden steps or riffles placed across the bottom of the trough. It was then run into large tanks, in which the suspended earth settled gradually. The operation took 30 days. The damp clayey mass was removed to a large shed, where by furnace and hot-air flues it was dried and made ready for the market.

In Bedfordshire, some deposits of fuller's earth occur in the Oxford or Middle Oolite, but the principal deposits of that county are at Woburn Sands in the Lower Greensand (Cretaceous), which here attains a thickness of 200 ft. The seams of fuller's earth are lenticular, and from 3 to 6 ft. thick. Blocks of the earth were used locally to purify the water of wells, to clarify peaty water, and to

get rid of the incrustations in boilers. Formerly the earth of Woburn Sands was exported to the United States, where it was used for bleaching American lard made from cotton-seed oil. Regular mining operations were carried out here. After drying, the clay was pulverised. The output from the Bedfordshire mines was never large, and ceased in 1915.

The most important fuller's earth deposits in England are at Reigate and Nutfield, Surrey, in Lower Greensand beds (Cretaceous). The fuller's earth is a very fine-grained clay which is interbedded with coarse-grained sands and sandstones, evidently deposited in shallow water. Nutfield fuller's earth is greenish-blue in colour, when unweathered, with occasional indications of bedding. Barytes with quartz forms large concretionary masses in it. The upper stratum of the Surrey deposits is described as being red in colour, passing into white, and of inferior quality. Under this lies the blue, the best of commerce, and below that a poor streak of yellow. The whole rests upon a coarse, dark sandstone. Near Nutfield Church the earth is 8 ft. thick; near Copyhold Farm, it is of a drab colour, 15 ft. thick, resting on hard sand, and at Redhill Common the thickness is 7½ ft.

Fuller's earth of high grade occurs in the Great Perran iron lode at Treamble, near Perranporth, Cornwall. It appears to be a decomposed "killas" (Palæozoic), overlies a high-grade phosphoric iron ore and has been proved in places to go to a depth of 50 ft. The bulk of the deposit is extremely white, and takes aniline and other stains exceptionally well for the purpose of making distemper, etc., and is also suitable for pharmaceutical preparations. It is estimated that there are fully 2,000,000 tons of fuller's earth available for exploitation. An experimental plant has been installed.

Fuller's earth also occurs in Shropshire, in the Ludlow Series (Silurian), and it has been found at Maxton, Roxburghshire, Scotland, but in neither of these localities is it in economic quantities. It was once mined and treated in Perthshire.

A bed of fuller's earth of good quality occurs at Rhiwlas, near Bala, Merionethshire, North Wales, which is as

much as 60 ft. in thickness, and a large deposit is said to have been discovered at Corwen in the same county.

India.—In India, fuller's earth is mined in the Central Provinces and in Rajputana. It is employed in the washing of cloths used in the manufacture of lac, indigo, etc., and is sold in the bazaars, in the form of small discs, to earth-eaters. At Colong, Bengal, a sort of fuller's earth called *sabun mitti* (soap-earth) is mixed with clay to form pottery, fire-bricks, crucibles, etc. A yellow unctuous clay or fuller's earth, called *multani mitti*, was being mined in 1874, at the village of Mar or Meth, near Kolaith, Bikanir, Rajputana, at the rate of 2,000 camel-loads per annum, and was sent to Multan. The clay is of Eocene (nummulitic) age. Thick beds of a similar clay were met with, interstratified with nummulitic limestone, at Palana, from which considerable quantities were raised and exported about 1896. At the village of Mandar, Jaisalmer, *multani mitti* has been quarried and exported on a considerable scale. In 1904, 534 tons were obtained in Bikanir and Jaisalmer. The output from Marwar, Rajputana, from 1914 to 1918, inclusive, amounted to 3,590 tons.

The average annual output of fuller's earth at Katni, Jubbulpore, Central Provinces, from 1909 to 1913 was 100 tons, and from 1914 to 1918 was nearly 200 tons.

A clay resembling fuller's earth was at one time imported into the Punjab from the interior of the Suleiman Range. In Multan itself, three qualities were imported: (1) white mitti, called *khajru* or edible; (2) yellow mitti or *bhakri*, used for dyeing clothes, and (3) light green or *sabz mitti* (green earth) used for cleaning the hair.

Soap sand, a kind of fuller's earth, is found in the Myingyan district of Burma.

In 1921 India produced 2,807 long tons of fuller's earth. There was no production in 1919 and 1920. In 1922 and 1923 the production was 13,550 and 27,696 tons respectively.

Australia.—At Wingen, New South Wales, fuller's earth occurs in the Permo-Carboniferous coal measures. The bed is nearly horizontal and 32 to 36 in. in thickness. The roof consists of sandy clay and the floor of sandstone.

The bed is separated from roof and floor by a few inches of carbonaceous clay. From 1912 to 1922, inclusive, about 267 tons of fuller's earth were raised from Boggabri, in the Narrabri division. There is said to be an immense deposit at Bell's Mountain and its vicinity in the division, but unfortunately it is situated far from any railway.

New Zealand.—A clay resembling fuller's earth has been found in three localities in New Zealand.

Deposits in Foreign Countries

United States.—Fuller's earth was first found in the United States in 1891, near Alexander, Arkansas, and in 1893 the important deposits at Quincy, Florida, were discovered.

The Arkansas deposits have already been referred to (page 461) as residual clays derived from basic dykes. The clay is mined by shafts and crosscuts, dried in sheds, crushed to pieces about 1 in. across, dried by hot air or steam in iron cylinders, broken up finer, pulverised and passed through bolting reels, or the fine earth is drawn off from the coarser materials by an air current produced by a suction fan. The earth is then packed into sacks for market. The Arkansas earth is used for bleaching cottonseed oil, lard, beef tallow and stearin. It is not used in refining petroleum.

In California, there is a large deposit near Elsinore in Riverside Co. Fuller's earth has also been mined in Calaveras, Solano, and other counties and is used in clarifying both refined mineral and vegetable oils.

Large deposits occur in South Dakota. At Fairburn, the fuller's earth is 9 ft. thick, with micaceous sandy clay forming the roof and micaceous sandstone the floor. The purer portions of fuller's earth consist of yellowish, gritty clay, with a somewhat nodular structure. At Argyle, the earth is 18 ft. thick, sandstone being the roof, and clay and earth the floor. At Minnekahta, the deposit is described as a fine-grained soft shale, 40 ft. thick, capped by red sandstone (Jurassic). Samples of the Fairburn fuller's earth bleached quite as well as the English earth.

Florida is by far the largest producer of fuller's earth in the United States. With the exception of those in Atachua Co., the deposits of Florida and Southern Georgia are of upper Oligocene age, and equivalent to the Alum Bluff beds. There are usually two beds of fuller's earth, 1 to 8 ft. in thickness, and separated by several feet of sandstone. The roof of the upper bed consists of sand rock, and the floor of the lower bed of sands. Elsewhere there may be only one bed. It was estimated in 1908 that 3,456 acres of land, or approximately 1 per cent. of the total area of Gadsen Co., is underlaid with workable fuller's earth. This area, with an average yield of 5,000 tons per acre, will supply 17,280,000 tons, or enough for about 500 years, at the present rate of consumption. Fuller's earth is known to occur in six other counties in Florida. In this State the overburden is removed by steam shovels, and the fuller's earth itself is mined in the open pit by pick and shovel, being loosened when necessary by blasting. The dressing and treatment is very similar to that employed in Arkansas. Florida earth is chiefly used in filtering mineral lubricating oils. The dried earth, after being ground to 60 mesh, is run into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. The oil which comes out first is perfectly water-white in colour, and markedly thinner than that which follows. The earth is also used to some extent for decolorising cottonseed oil and lard oil, but the English fuller's earth is better for these purposes.

A particular form of Florida fuller's earth is known in the trade as "floridin." One of its uses is for decolorising wax obtained in the refining of shale-oil. For this purpose, it is used in a granulated form, passing a mesh of 16 to 30 holes per linear inch, and is previously ignited to a temperature of about 900° F., it being most important that all moisture, free or combined, should be driven off before use. The best results are obtained by filtration through a long column of the material.

The deposits of Georgia are mined at Attapulgus and Pikes Peak. Attapulgus is in Southern Georgia, and the fuller's earth, which may be regarded as a northern extension of the Florida deposit (Oligocene), is 11 ft. in thickness,

with a roof of clayey sand, 2 ft. thick, and a floor of argillaceous sand.

The deposit at Pikes Peak, Twiggs Co., is in Central Georgia, and occurs in the Jackson group of the Eocene. Here are two beds of fuller's earth. In one exposure, light cream-coloured earth of commercial value, 17 ft. thick, rests on dark-coloured earth 5 ft. thick, which is succeeded by 1 ft. of yellow, straw-coloured earth. The whole lies on greenish yellow sands. The overburden, consisting of various sands, is 35 ft. in thickness. In this area generally the maximum thickness of the upper bed is 30 ft., and the maximum overburden is 60 ft. The lower bed is thicker but of inferior quality, and has 100 ft. of overburden. The earth of this deposit is used in refining vegetable and animal oils, especially cotton oil and linseed oil. In preparing the earth for the market, silk bolting cloths of 16, 30, 60 and 100 mesh per linear inch are used.

There is a large deposit of fuller's earth at Olmstead, Illinois, belonging to the Midway Formation of the Tertiary. The earth is being dug in an open pit. The overburden consists of 10 ft. of sand and loam. Below this is fuller's earth of the best quality, 34 ft. thick, which is above earth of an inferior grade 30 ft. thick. The fuller's earth is screened, the fine material being used for filtering lard, vegetable oils, etc., and the coarse for the bleaching and filtration of mineral oil. It is estimated that 4,000,000 tons are available here.

Fuller's earth occurs as glacial silt near Clinton, Massachusetts. One mile north-east of Lancaster there is a pit showing 8 ft. of laminated clay beneath 5 ft. of sand and gravel. The deposit is owned by an English firm, the material being used for fulling cloth. The clay is said to be also used as a binder in the manufacture of emery stone.

A fuller's earth deposit is reported to have been opened at Clarkeville, Mercer Co., Pennsylvania.

There are fuller's earth deposits in Texas. Three miles north of Somerville, Burleson Co., is an exposure in a clay pit of 12 ft. of brown fuller's earth, which dips beneath hard grey sandstone (Eocene). This deposit was worked in 1909 and 1910. Near Burton, Washington Co.,

a bed of fuller's earth averages 5 ft. in thickness, but it is covered by 6 ft. of overburden. This was worked in 1909. A drill hole sunk near this pit disclosed three beds of fuller's earth, about 16 ft. in thickness in all. Drill holes put down on the Tatum Farm, near Barton, showed from 9 to 27 ft. of fuller's earth, and from 4 to 11 ft. of stripping (overburden). The roof or overburden consists of grey sandstone, and the floor of a loose, porous, bluish sand. There are other clays, approaching fuller's earth, in Burleson Co. Near West Point, Fayette Co., a bed of fuller's earth, 6 to 16 ft. thick, lies under 2 to 10 ft. of overburden. It is overlain by 2 ft. of Pleistocene gravel.

Fuller's earth also occurs in Alabama, South Carolina, Colorado, and other States.

Other Countries.—Fuller's earth, believed to have been derived from halloysite or smectite, has been mined in France. From 1900 to 1901 the production amounted to 7,000 long tons. In the latter year it was obtained near Louviers, in the Department of Eure.

The fuller's earth of Saxony, Germany, has already been mentioned (page 461).

Fuller's earth has been quarried on a large scale in the Kutahia district, Asia Minor. The deposits are said to extend over 60 miles in length. At Eskishehr, about 30 miles north of Kutahia, the earth is 3 ft. in thickness and is sometimes found overlapping meerschaum. Fuller's earth is also found in the vilayet of Angola.

In Morocco, a kind of fuller's earth is found, called *ghasool.* The incinerated earth (*kissermill*), in conjunction with lime and sand, is said to furnish a very hard mortar.

It is reported that fuller's earth occurs abundantly in Java.

THE AGRICULTURAL AND FOREST RESOURCES OF THE GAMBIA

THE Colony and Protectorate of the Gambia is the smallest and also the oldest of the British West African Possessions. A patent was granted by Queen Elizabeth in 1588 to merchants in London and Exeter to trade with

the country, and thirty years later the first settlement, Fort James, was built on a small island in the River Gambia by a party of London merchants styled "The Company of Adventurers of London trading in Africa." In 1816 a new settlement was formed on Banjola Island (re-named St. Mary's), at the mouth of the Gambia River, by English merchants who had left Senegal when that country was given up to the French. Bathurst, now the capital of the Gambia, was laid out at this time. The Colony was at first subject to the Government of Sierra Leone and after various changes of administration was granted a separate Government in 1888.

Although settled so long ago the country has not developed to the same extent as the other parts of British West Africa. Agriculture is the only important industry of its people and the prosperity of the Colony is dependent on the production of one export crop, ground nuts. The seriousness of this position has long been realised, and in 1920 Mr. M. T. Dawe, F.L.S., who has had a wide experience of agriculture in tropical Africa and elsewhere, and is now Commissioner of Lands and Forests in Sierra Leone, was appointed by the Colonial Office to report on the agricultural needs of the Colony with a view to submitting recommendations as to the desirability or otherwise of establishing an agricultural service. After a tour lasting for more than two months Mr. Dawe submitted a report which was published for the Government of the Gambia by the Crown Agents for the Colonies in 1921. The report contains valuable information, not only on the agricultural conditions of the Gambia, but also on the country generally, and the present article has been compiled largely from this source, supplemented by other publications, particularly a Report on the *Agricultural Position and Requirements of the Gambia*, 1923, by Mr. Archibald J. Brooks, F.L.S., F.C.S., the Director of the newly formed Agricultural Department in the Colony.

GENERAL

The Gambia is the most northerly of the British possessions in West Africa, lying between 12° 10′ and 13° 15′

N. Lat. and between 13° 50′ and 16° 40′ W. Long. It consists of a narrow strip of land bordering the River Gambia for a distance of about 4 miles from each bank and extending eastwards from the coast for over 250 miles. It is bounded by French territory on the north, east and west. The total area of the country is approximately 4,000 sq. miles, or about the size of Cornwall and Devonshire together. The population at the 1921 census, exclusive of the migratory farmers referred to later (see p. 479), was estimated at about 210,000.

The native population is made up principally of four races, known as Mandingos, Jollofs, Fullahs and Jolahs, each having a more or less distinct language. With the exception of the last-named race, who are pagans, the natives are mostly Mohammedans. They are, on the whole, of a quiet nature and disposition, and appear to be remarkably law-abiding and peaceful. They are born agriculturists, apparently willing to follow the advice of the Government as to the crops to grow and, in Mr. Dawe's opinion, with careful handling could probably be led to adopt improved methods of cultivation.

With the island of St. Mary's, the whole country is under the Protectorate system of administration, and is divided into five Provinces, viz., North Bank, MacCarthy, Upper River, South Bank, and Kombo and Foni. A European travelling Commissioner is in charge of each Province, which in turn is divided into districts, each of which is under a Head Chief, while each town or village has its headman. The headquarters of the administration are at Bathurst, the only town of any size in the country and the centre of its commercial activity.

There are no railways in the country and only one metalled road, 7½ miles long, from Bathurst to Cape St. Mary, crossing the Oyster Creek Bridge which connects the island of St. Mary's with the mainland of British Kombo. The Gambia River, however, forms an unrivalled highway for 300 miles. It is a clear-flowing river with well-defined banks and a remarkable absence of aquatic plants, which are so obstructive to navigation in many African rivers. It is navigable for ocean-going steamers drawing 12 feet

of water as far as MacCarthy Island, 176 miles from Bathurst, and for smaller craft, drawing 6 feet of water, practically as far as the frontier. Except in the coast belt there are few districts where produce has to be transported more than a few miles to a river port, so that the absence of good roads is not felt.

As regards climate, Gambia is a country of extremes. It is excessively wet from June to October, but for the rest of the year the climate on the whole is dry and agreeable, the nights being comparatively cool. The harmattan, a dry easterly wind, prevails during the months of December, January and February, and during this period there is often great variation in temperature, sometimes ranging from 50° or less at 6 a.m to 90° or more between 2 and 3 p.m. On this account pneumonia is common amongst Europeans at Bathurst. The lowest temperature recorded was 41° in March, 1909, and the highest 105° in the same month and again in April 1911. The annual rainfall has fluctuated considerably since 1884 when records were first kept at Bathurst. The average for the 37 years ending 1920 was 47·62 in., the heaviest being 80·90 in. in 1884 and the lowest 23·68 in. in 1913.

Soil and Distribution of Vegetation

The land of the Coast Provinces is for the most part level and of a light sandy loam. There are but few traces of laterite outcrops, but as one proceeds up river, ironstone becomes more and more in evidence, many of the ridges standing 50–100 ft. above the level of the surrounding country. Where there are no ironstone hills, there is usually a flat tract of land, extending in some cases to a mile from the bank, but more generally for a distance of 200 to 500 yards, which is flooded every wet season. Similar land is found along the creeks and some of the streams. This land is usually composed of grey, sandy soil, and where not impregnated with salt, is employed for the cultivation of rice in the wet season.

Between the lowlands and the outlying ironstone tablelands is the savannah, which occupies the greater part of the Protectorate. This is usually covered with tall

grasses interspersed with trees of a spreading habit, which in places grow thickly to form dense woodland. It is on this savannah land that the ground-nut and millet crops are grown. True forest is nowhere found in the Gambia.

As regards the vegetation along the river, as far up as salt or brackish water reaches, the muddy banks of both river and creeks are covered with mangrove trees and scrub. Beyond this the oil palm, piassava, rhun, raphia and branched doum palms make their appearance. Next the mahogany and other large trees are conspicuous on the banks, while farther up the river, where the banks are higher, smaller trees, bamboos and shrubs are found.

Trade

Ten years ago France controlled more than half the commerce of the Gambia, supplying large quantities of cotton goods and rice, and being the chief buyer of ground-nuts. During the war the trade was largely transferred to the United Kingdom, and to-day this country still leads both in imports and exports, although France is gradually recovering a large proportion and Germany is also taking a considerable share. The value of the Gambia imports and exports (including re-exports) from and to these countries in 1913 and 1923 is shown in the following table :

—	1913.		1923.	
	Imports	Exports.	Imports.	Exports.
	£	£	£	£
United Kingdom . .	387,424	62,393	444,329	440,368
France	505,397	428,012	103,773	343,288
Germany	63,512	162,718	54,606	62,764
Total, all countries . .	1,091,129	867,187	813,898	899,509

The chief items in the import trade are cotton goods, manufactures and yarns, now obtained mainly from the United Kingdom, but, as mentioned above, supplied largely by France ten years ago ; kola nuts from Sierra Leone ; rice from Germany and France ; and tobacco from the United States. The value of the imports of these articles into the Gambia in 1913 and 1923 was as follows :

	1913.	1923.
	£	£
Cotton piece goods	201,797	232,770
Cotton manufactures		43,927
Cotton yarn		28,128
Kola nuts	91,381	104,704
Rice	62,512	70,117
Tobacco	15,488	33,995

The preponderating position of ground-nuts in the export trade is shown in the following table, which gives the quantity and value of the principal articles of local production exported in 1913 and 1923; further particulars regarding the trade in ground-nuts are given later in the section on that crop (p. 479).

—	1913.		1923.	
	Quantity.	Value.	Quantity.	Value.
		£		£
Ground-nuts	67,404 tons	624,415	62,564 tons	851,847
Palm kernels	545 tons	9,026	392 tons	5,640
Hides	47,031	18,717	6,962	2,009
Calabashes	—	2,210	—	1,858

In 1913, 2,995 lb. of rubber, valued at £1,026, and 31,518 lb. of beeswax, valued at £989, were exported, but these articles do not appear in the returns for 1923.

AGRICULTURAL RESOURCES

As has been already mentioned, the ground-nut is the only crop grown in the Gambia for export. Other crops cannot be introduced with success until the native methods of cultivation have been improved, and then only after the suitability of the local conditions has been definitely proved by trials at a Government Experimental Farm. For the present, therefore, the Department of Agriculture are concentrating their attention on the improvement of the ground-nut crop and the crops grown for native food. The Department, which was started in 1922 in accordance with recommendations contained in Mr. Dawe's report, has not yet been fully developed. In addition to the Director, an Agricultural Superintendent has been appointed, and when the Department has been fully

staffed and an Agricultural and Botanic Station established, it will be possible for considerable progress to be made in developing the agriculture of the country.

Methods of Cultivation

The existing native methods of cultivation are of the simplest possible type. The crops are grown on ridges, the implement used by the Mandingos and Jollofs for throwing up the ridges being a large, flat, wooden-bladed hoe made of rosewood, the toe or rounded point of which is shod with iron. The handle of the hoe is short and is tied to the blade at an angle of about 20° so that the native has to bring his hands almost to ground level when using it. The Jollahs use a kind of hand plough, which consists of a flat wooden blade attached to a long handle and is pushed in front of the operator who works in a more or less upright position. For weeding, a small iron draw-hoe is used by the Mandingos, whilst the Jollofs use for this purpose a heart-shaped hoe with a small handle employed as a thrust hoe. Animal-drawn ploughs are not employed in the country. They were introduced by the Catholic Mission at the Abuko Agricultural School some years ago, but without practical results.

Mr. Dawe considers that one of the special objects of the Experimental Farm, which he recommended should be established, would be to demonstrate the value of improved agricultural implements and machinery, such as animal-drawn or mechanically-driven ploughs and cultivators, and machinery for planting and harvesting ground-nuts. He regards the country as particularly well adapted for mechanical ploughing, as the land is flat and the soil light and easily worked, whilst there are abundant herds of cattle from which oxen could be selected and trained for ploughing. Mr. Brooks, on the other hand, is of opinion that light hand ploughs would be preferable to the heavier ox-drawn kind, and is introducing several types, one of which can be worked by a single man by means of a cable, while others can be drawn by a pair of donkeys or a few men. He has also imported a number of West Indian hoes which will be employed in the Experimental Stations.

Ground-Nuts

The short rainy season, followed by a long period of dry weather, which is characteristic of the Gambia climate, and the light sandy soil of the country, are specially suited to ground-nut cultivation. The following is a brief outline of the native methods at present usually followed in growing the crop and the suggestions that have been made for improving the quality of the nuts produced.

Seed is supplied to the native growers every season by the Government, who usually purchase it from the exporters. In this way an annual change of seed in each district can be ensured. Every few years the Government imports seed nuts from Senegal in order to maintain the quality. These measures, although fairly satisfactory, are capable of improvement, and other methods have been proposed which are dealt with below (p. 481).

The land is prepared by burning off the scrub, grass and weeds before the rains set in, and as soon as the rain commences the surface soil is scraped into ridges by the primitive implements already referred to. The seed is sown on top of the ridges and subsequent cultivation consists in two or three weedings.

Insect pests do not seem to trouble the ground-nut plant to any appreciable extent. A small beetle (*Trilobium confusum*, Duv.) sometimes attacks the nuts when stored, but as the nuts are, as a rule, sold and exported soon after harvesting, it has little chance of doing serious damage. Leaf-spot disease (*Cercospora personata*, Ellis) is prevalent and affects the yield of nuts considerably. It only occurs in patches in a field and does not cause wholesale destruction of the crop. Mr. Brooks, during a trek of 430 miles through the ground-nut districts, found every farm visited infected with the disease. Two other diseases are also met with, one apparently a rust (*Uredo arachidis*, Lagh.), and the other probably a root disease.

The plants are lifted in October and November, four months after planting, by which time the rains have ceased, and are stacked on the ground or on raised platforms. After a short time the nuts are beaten off the

dried plants by a hooked stick. They are then winnowed by being gently jerked from a basket held high above the head at a time when there is sufficient breeze to carry away the chaff. The nuts are then sacked, and are either conveyed to the wharf town for sale, or sold to traders at the villages. Definite statistics from which the yield can be calculated are not available, but it has been estimated that the average yield for the whole country is 44 bushels per acre.

The dried haulms after the nuts have been beaten off provide the principal food for the horses and cattle from the middle to the end of the dry season. Their feeding value, however, is largely reduced by the method of threshing by which most of the leaves are beaten off. Hand-picking the nuts would not only result in cleaner produce but also in a more valuable fodder.

No figures are available for the production of ground-nuts in the Gambia, but the following table shows the total export of locally produced nuts during 1913 and the last three years and the quantity, with the value, taken by the chief importing countries. In addition there is a small re-export trade.

Exports of Ground-Nuts

Country of destination.	1913.		1921.		1922.		1923.	
	Tons.	£	Tons.	£	Tons.	£	Tons.	£
United Kingdom .	985	10,700	43,289	460,244	30,705	377,921	30,448	415,568
France .	42,421	385,662	13,673	148,079	22,710	271,606	24,220	333,329
Germany .	17,137	162,403	—	—	—	—	5,309	62,468
Holland .	4,440	39,967	—	—	6,715	87,750	—	—
Belgium .	—	—	972	7,780	1,381	15,191	2,500	39,250
Total, all Countries .	67,404	624,415	58,273	620,2[illegible]7	62,978	767,197	62,564	851,847

Farming is not limited to the native population. It has been estimated that half the ground-nut crop is grown by immigrant farmers, "strange farmers" as they are called in the Gambia, who come from neighbouring French territory specially to cultivate the crop and return home when it has been harvested. In 1915 there were over 32,000 such farmers, but the numbers have since fallen off, and in 1922 there were only 22,500 and in 1923 still fewer. In view of the inadequate native population,

it would seem desirable that special inducements should be offered to these immigrant farmers to settle permanently on the land. There are large tracts of land in every Province at present not being worked, and Mr. Brooks recommends that certain of these areas should be set aside and handed over to the strange farmers on the understanding that they will work them efficiently.

For some years past complaint has been made as to the high percentage of foreign matter contained in groundnuts exported from the Gambia. Shipments have contained as much as 17½ per cent. of foreign matter, whilst 5 or 6 per cent. is of usual occurrence. In some cases there has been deliberate adulteration by the addition of sand, etc., whilst admixture of the nuts with broken haulms, shells, dirt, etc., is far too common. Legislation has been introduced to prevent adulteration and improve the quality and a number of produce inspectors have been appointed. According to Mr. Brooks, although some improvement has undoubtedly taken place, many difficulties have arisen in carrying out the provisions of the Ordinance. Merchants themselves have come to no definite understanding on the subject, and if one merchant or his buying agent refuses to purchase dirty or adulterated nuts his neighbour will accept them. If all merchants were to combine in this matter and report cases of wilful adulteration to the police the practice would stop, but so long as merchants are willing to buy inferior produce on the same terms as produce of a higher quality, it will be forthcoming and no system of Government inspection will stop it.

Apart from the question of adulteration, the quality of the nuts themselves could be greatly improved. Mr. Brooks attributes the relatively inferior quality of the Gambia nuts to impoverished soil conditions, brought about chiefly by the persistent burning of all organic matter on the soil, to absence of tillage, to neglecting to select seed for sowing, and to disease. From an inspection of numerous samples taken from stacks in the field and at buying depots, he found that a very high percentage of the total nuts were shrivelled. This was, in his opinion, due mainly to disease and partly to the nuts being har-

vested too soon. Obvious remedies are, therefore, improvement in methods of cultivation, prevention of disease and an efficient system of seed selection. As regards the last-named, Mr. Dawe recommended in his report that a ground-nut seed-farm should be established with the object of supplying farmers with specially grown and selected seed. In this connection Mr. Brooks proposes to raise seed-nuts of approved quality at the Botanic Station, to increase the supply by growing the nuts on communal farms under the direct supervision of an officer of the Agricultural Department, and then, after disinfecting the seed, to issue it to the farmers in exchange for a similar quantity of their own crop of seed-nuts, which would be sold in the usual way for export and so recoup some of the cost of running the scheme.

Food Crops

The principal grain crops of the country are guinea corn, millets, rice and maize. Insufficient is grown, however, for the native requirements, and as already mentioned, large quantities of rice have to be imported to augment the supplies. Much more food could be grown in the country, and in order to secure an adequate supply for the population Mr. Dawe recommended the cultivation of rice during the dry season under irrigation, and suggested that irrigation engineers should be appointed for a fixed period to survey the most appropriate sites for irrigation. At present rice is grown in the low or swamp lands and its success is entirely dependent on the rainfall, which, as already pointed out, varies greatly from year to year. A considerable number of varieties are grown, and the rice produced is of good quality and is preferred by the natives to the imported grain. Throughout the Gambia rice cultivation is performed entirely by the women, whilst the dry land cultivation of the groundnut, as well as of guinea corn and millet, is done by the men. Any extension of the rice-growing industry would therefore not affect the labour required for the groundnut industry.

Cassava, yams and sweet potatoes are grown in some

districts, as well as two or three kinds of beans and cow-peas. The cultivation of food crops, such as these, which can be stored for 6–8 months, is being encouraged by the Agricultural Department.

Coconuts and bananas are grown on a small scale at Bathurst, but the conditions are not favourable for their cultivation on a commercial scale for export. Okra, papaws, oranges, mangoes and tomatoes are also grown for local consumption. Sugar cane is grown in a few gardens at Bathurst, and the cane, cut into small pieces, is sold in the local markets, but it is nowhere grown in the Protectorate.

Cotton

Apart from ground-nuts and food crops, cotton is the only other product cultivated to any appreciable extent. In some parts in the interior, cotton fields, 5 acres or more in extent, are not uncommon. The entire crop is utilised by the natives for making yarn which is woven into narrow strips of cloth called "pagns." These are sewn together to make very strong and durable native garments. Attempts have been made from time to time to induce the natives to grow cotton for export, but without success; in fact, at present they cannot satisfy their own needs and large quantities of yarn, as well as manufactured goods, are imported. Although much could doubtless be done to improve the quality and quantity of the crop by more thorough cultivation, the climatic conditions are unfavourable and the bolls do not mature sufficiently before the dry weather sets in. It is not considered advisable to encourage the cultivation at the present time, as the returns are not commensurate with the area devoted to the crop and the labour bestowed on its cultivation.

Owing to the importation of different varieties in the past, the plant grown to-day is of a mixed character. There are, however, two more or less distinct types in general cultivation, one being grown as a perennial and as a mixed crop, and the other as an annual separately. Two samples collected by Mr. Dawe were sent to the Imperial Institute in 1920. The lint was of similar grade

to "good middling Upland" and one was considered to be worth 1*d.* per lb. in advance of "middling" American, but both gave an abnormally low ginning yield (see this BULLETIN, 1921, **19**, 146).

The lint is usually separated from the seed by hand and the seed is not utilised. Mr. Dawe recommends that simple wooden hand gins, similar to those used in parts of India, should be introduced. Their use would not only save labour but the seed could be collected and the oil extracted locally in place of imported cotton-seed oil, of which over 69,000 gallons, valued at £14,000, were imported in 1923.

Introduction of New Crops for Export

Mr. Dawe discusses the prospects of cultivating other crops than the ground-nut for export. First among these he places tobacco, which he considers could be grown successfully on a commercial scale. Before this could be done, however, experiments would have to be carried out by a competent agriculturist, and in his recommendations for the staff of an Agricultural Department he included a tobacco expert. Other crops suggested included maize, rice, and citrus fruits. Sisal hemp would probably grow well, but its cultivation in the Gambia is not recommended, as it is not suited to native farmers, since it requires large areas under cultivation and the installation of costly machinery. Mr. Brooks does not consider it advisable at present to push the cultivation of any new crop on an extensive scale, as existing industries should first be stabilised and the general agricultural standard raised before new industries requiring skilful cultivation are attempted.

Livestock

There are fairly large herds of cattle in the Protectorate owned by the native chiefs. The cattle are rather small in size, and on the whole keep in good condition, although periodically many of them are carried off by disease. This was the case in 1922, when 2,000 animals died in the Upper River Province alone. The symptoms indicated contagious pleuro-pneumonia, which ravaged

the Protectorate in 1917. The services of a veterinary expert are required, together with an efficient staff to carry out his instructions. In the dry season the cattle are tethered at night near the villages on the ground-nut or millet fields, where they are fed on ground-nut hay.

Forest Products

The absence of true forest in the Gambia has already been mentioned, and is, as Mr. Brooks remarks, the most conspicuous feature of the Protectorate. Under the present system of shifting farms, forests can never be re-established naturally, and it will be one of the objects of the Agricultural Department to raise trees for distribution to the native chiefs for planting.

The chief timber trees of the country are described in Mr. Dawe's report. There is at the present time but little export of timber, though occasionally small shipments are made, principally to French and Portuguese Possessions. The timber of the African mahogany tree (*Khaya senegalensis*), the largest important timber tree in the Gambia, was exported to a considerable extent at the beginning of the nineteenth century. The tree is common along the Gambia River, above the mangrove limits, and in other parts of the country. Rosewood (*Pterocarpus erinaceus*) is also common in many parts of the Gambia and is valued for local uses. Other timber trees occurring in the country include *Parinarium excelsum*, *Paradaniella Oliveri*, *Eriodendron anfractuosum* (kapok), *Cola cordifolia*, *Lophira alata* (African oak), *Detarium senegalense*, *Erythrophloeum guineense*, *Afzelia africana*, *Parkia africana* and *Borassus flabellifer* (rhun palm).

Rubber, obtained principally from the vine *Landolphia Heudelotii*, was at one time an important export product, 146,573 lb. being exported in 1901, but none has been shipped for several years. The plant is most abundant in the bush land of the Foni country. Rubber has also been obtained from *Ficus Vogelii*, a large tree common at Bathurst and elsewhere in the country. Various exotic rubbers, including the Ceara tree, have been introduced,

but with no practical result. The climate is too dry for the more important Para rubber tree.

The oil palm (*Elaeis guineensis*) is found in most parts of the Protectorate, but appears to be more abundant in Kombo and Foni Province. On the northern bank of the Gambia River it is confined to the river bank and to the creeks and streams, being rarely found on the drier lands. Only the kernels are exported and small quantities of palm oil actually have to be imported to meet the local demands. There is, however, a good deal of traffic in palm wine. Large areas exist where nuts are not collected to any extent and it would seem that there is considerable room for expansion in this important industry. The fruits are smaller than those of other countries and this may be due to the frequent tapping of the palms for wine.

Of fibre-producing plants indigenous to the country, mention may be made of the wine palm (*Raphia vinifera*), from which piassava is obtained; *Raphia Ruffia*, the source of raffia; *Sansevieria senegambica; Adansonia digitata* (baobab), the bark of which has been used for paper-making; and species of *Hibiscus, Triumfetta* and *Urena lobata*, which yield fibres of the jute class. Of these only piassava has been exploited commercially. A factory installed with machinery for the extraction of the fibre was erected on the Gambia River, but it has not been kept in operation owing to local difficulties. The export of piassava in 1918 was only 26 tons. Jute was at one time grown experimentally and fibre of good quality was obtained, but the yield was stated to be small and unremunerative.

The only indigenous tanning material used in the country appears to be the pods of *Acacia Adansonii*. A mangrove tree (*Rhizophora racemosa*) is very abundant along the river and creeks within reach of salt water, but the bark is not used locally. A specimen of the bark examined at the Imperial Institute was rather poor in tannin (see this BULLETIN, 1921, **19**, 147).

NOTES

Inchi Grass Oil.—In connection with the report on the examination of inchi grass oil (*Cymbopogon caesius*, Stapf) at the Imperial Institute (this BULLETIN, 1924, **22**, 268) attention may be drawn to a detailed investigation of the oil carried out in Travancore by K. L. Moudgill and K. R. Krishna Iyer (*Perfumery and Essential Oil Rec.*, 1922, **13**, 292). The following constituents were identified: *l*-borneol, *l*-terpineol, *l*-camphene, and *l*-limonene, but neither citral nor geraniol could be detected. The yield and constants of the oil obtained from different parts of the plant were also determined. It was shown that the flowers furnished more than twice as much oil as the leaves, namely, 1·5 per cent., and that the plant contained a larger percentage of alcoholic constituents in the earlier stages of its growth than at later periods.

Mineral Production of India.—The annual review of the mineral production of India for 1923 is published in *Rec. Geol. Survey India* (1924, **56**, 109). Increased mining activity in Mysore State led to the production of more than twice the total amount of chromite obtained in 1922. Coal shows an increased production and also an increased export, whilst the imports were much less except from South Africa, which country contributed twice as much as the next highest (the United Kingdom). Although copper ore shows a large decrease on account of the closing of the Rakha mines, very promising ore bodies have been met with in the Mosabani mines, which promise an improved production. The output of iron and steel shows a considerable expansion. Lead ore production by the Bawdwin mines increased, and a high grade silver-copper ore from the Shan lode has been developed. A large growth in the production of manganese ore is attributed to an increase in available labour caused by a poor harvest; the quantity exported to the United Kingdom continued to be very large. Exports of mica were nearly twice as great as in 1922, but the average price fell from £8 18*s*. to £6 10*s*. per cwt. The petroleum output fell from 305½ million gals. in 1921 to 298½ million gals. in 1922, and 294¼ million gals. in 1923. The largest Burma fields showed decreases, and the report states that the Yenangyat field is dying and that the Badarpur field shows no promise of making any substantial contribution to the Indian production. However, these declines are largely compensated by increases from the Punjab and Digboi fields. A

large refinery has been erected at Rawalpindi to deal with the oil from the Kaur field, Punjab. It has a capacity of 65,000 gals. of crude oil daily. There was a very heavy fall in the exports of zinc ore from Bawdwin. The most notable increases in the production of minor minerals occurred in the case of fuller's earth and steatite.

Mineral Resources of Papua.—A report on the geology of Papua by Evan R. Stanley, Government Geologist, Papua, dated July 14, 1923, has been published recently. It embodies not only Stanley's own work on the geology of Papua, but refers also to that of J. E. Carne and others. A. Wade and geologists of the Anglo-Persian Oil Co. have worked on the late Tertiary (Miocene and Pliocene) deposits, i.e. those areas in which oil and oil indications have been noted and reported; a table, based on their results together with later deductions, shows the general grouping and thickness of the Plio-Miocene Series. A correlation table of these same rocks of Papua and New Guinea is also given, and the geological succession of the whole of the Papuan rocks is indicated.

Tertiary, Mesozoic (Cretaceous and probably Jurassic), Palæozoic (Middle Devonian) and Archæan rocks are represented in Papua. The Archæan rocks form two great groups: (1) The Owen-Stanley Series (Pre-Algonkian), forming the backbone of the Territory, and (2) the Astrolabe-Kemp-Welch Series, the lower beds of which correspond to the Huronian (Pre-Cambrian), while the upper beds may be Palæozoic. The igneous rocks are effusive (andesites, basalts, trachytes, etc.), hypabyssal (porphyries, lamprophyres, dolerite, etc.), and plutonic (grano-diorites, granite, etc.).

The more important mineral occurrences found in the Territory comprise gold, copper, osmiridium, petroleum, sulphur, iron, coal, mica, pottery clays, and, among gem stones, beryl, amethyst, spinel, garnet, epidote, olivine, topaz, sapphire and agate.

Reef *gold* is not now being worked in Misima, and most of the gold at present being won in Papua is alluvial. The reef gold is intimately associated with decomposed porphyrites and diorites, impregnated and traversed by quartz veins, themselves carrying gold. Fissure veins of auriferous quartz are also common. The alluvial gold has been shed from the Pre-Cambrian metamorphic zones of the mountainous country and concentrated in a few of the larger river systems, a number of which are now being worked. No gold dredging has been undertaken as yet. From 1888–9 to 1921–2, the yield of gold was

508,690 oz., of value £1,635,850. The Murua goldfield in the South Eastern Division has proved the most productive, with a total estimated output of 189,818 oz.

In the Astrolabe mineral field the Dubuna *copper* mine (see Imperial Institute Monograph, *Copper Ores*, 1923, p. 86) has been brought to a profitable stage, and is now under option by the Laloki (Papua) Copper Mine, N.L. This company has under construction ore bins, houses, roads, bridges, etc., and has negotiated with the Government for concessions on the Rouna Falls, for the purpose of generating electric power for the mines. Much development work has been carried out in the mines. The ore-bodies are lenticular in shape, and are mostly connected with one another by slight indicators. They have been formed by replacement. Enrichment is frequently associated with cross-faulting. The enriched sulphide portion carries covellite, cuprite, chalcopyrite and bornite, with sometimes an appreciable percentage of gold and silver. From 1906–7 to 1921–2, 11,467 tons of copper ore were raised in Papua, of value £128,42..

Osmiridium (nevyanskite) has been found in almost every goldfield in the Territory. It has been shed from serpentines and peridotites, occurring as belts in the Northern Kumusi and Central Divisions (see Imperial Institute Monograph, *Platinum Metals*, 1920, p. 30).

Petroleum in commercial quantities has not yet been obtained in Papua. Boring is now being carried out in the Popo region (see Imperial Institute Monograph, *Petroleum*, 1921, p. 39).

There appears to be some doubt as to the occurrence of *mercury* in Papua, as many specimens of supposed cinnabar brought in from certain localities have proved to be hæmatite (compare Imperial Institute Monograph, *Mercury Ores*, 1923, p. 30).

Hæmatite has been mined in a small way in the Rigo district. It is a surface ore which frequently carries a high percentage of copper. This mineral possesses an excellent morocco-red colour, and has been exported in small quantities as a pigment. It is locally known as *red oxide*, and has been sold at £12 to £15 per ton.

Seams of *lignite* are associated with the petroleum beds in the Tertiary formations, but they are in too remote a situation to be commercially workable.

Some large flakes of *mica* have been found on both Normanby and Ferguson islands, and the mineral might be worth prospecting for.

The *sulphur* flats at Iamalele are gradually being built up by numerous fumaroles, the sulphur subliming about

the orifices. It has been estimated that there are 42,000 tons of sulphur available at the surface, about 1 mile inland from Seymour Bay, but at present no work is being done in the area.

Some parts of the Central Division are well provided with *pottery clays*.

The report contains a geological map, numerous photographs and a list of references to literature on Papua.

Mineral Resources of Cyprus.—The following notes are abstracted from a paper by C. Gilbert Cullis, entitled "A Sketch of the Geology and Mineral Resources of Cyprus," read at a recent meeting of the Royal Society of Arts (*Journ. Roy. Soc. Arts*, Aug. 1, 1924, 72, p. 624).

The oldest sedimentary rocks are the Trypanian, which forms the ridge of the Kyrenia Mountains, and consist of massive limestones and dolomites, believed to be Cretaceous. Some thin-bedded shaly limestones which flank the Trypanian beds on both sides of the range are thought to be Eocene. The Trypanian is principally noted for its ornamental *marbles*, especially where they have been crushed and recrystallised or intruded by igneous rocks. The Kythrean Series, above the Trypanian, is mainly Oligocene, consisting of sandstones, sandy shales, breccias and conglomerates. Certain of the sandstones are suitable for building stone, paving stones, etc.

The Idalian Series, which rests on the Kythrean, is mainly Miocene. *Gypsum* has a wide distribution in the basal marks of this formation, and is quarried in several places. The laminated mineral is extensively quarried, under the name of "marmaras," for interior paving slabs. From 1915 to 1921 inclusive, the total exports of gypsum amounted to 25,689 long tons. *Umber* is found where the Idalian marls are in contact with igneous rocks, and is quarried in two districts. Most of it is shipped as "raw umber," and some of it is calcined to "burnt umber." In 1917, 1,881 tons were exported. *Manganese* occurs scattered through the umber, and, where the rock has been exposed to long-continued erosion, it has become concentrated on the surface or in the soil. North of Yerasa, *blende* with a little pyrite and chalcopyrite occurs in a mass composed of siderite, dolomite, etc., in close association with gabbro, but its economic value is unknown. *Flints* and bedded cherts are plentiful in the chalk of the Idalian. In contact with igneous rocks silicification has taken place locally, resulting in the formation of *jaspers*. These are used in making the "dhoukani" or agricultural instru-

ment employed for threshing, which consists of flints embedded lengthways in rows on the underside of a long, wide board, which is dragged by mules or oxen over the threshing-floor on which the reaped corn has been spread. Some of the purer limestone is burnt for *lime*, and, east of Dali, *freestone* is used for making stone vessels, fire-bricks, etc.

The principal development of igneous rocks is in the Troödos Mountains. The important deposits of *copper* ore found in the pillow-lavas have already been described in this BULLETIN (1923, **21**, 528). The gossans of the pyritic masses in the pillow-lavas sometimes contain *brown iron ore* of good quality, and, here and there, in such quantities as could be exploited for *ochre* if not for iron ore. Other iron ores, as magnetite and specular hæmatite, are enclosed in dolerite. *Chromium* occurs as a constituent of peridotite or serpentine. Several small parcels of ore have been sent to England from the Paphos district, but the cost of production was prohibitive. More recently, prospecting on the north slope of Troödos has resulted in the discovery of deposits estimated to contain at the surface, or at very shallow depths, several thousand tons of chromite. A private company has begun to exploit these deposits. The following percentage analyses show the quality of the ore :

Chrome Ore from Troödos

(Dried at 100° C.)

Chrome oxide	48·90	51·88	50·80	51·65	49·74
Iron	13·47	12·75	12·48	12·36	12·33
Silica	4·43	1·93	2·25	2·15	3·26
Magnesia	16·79	16·65	16·50	16·95	17·22

Serpentine-asbestos (short-fibre chrysotile) and *amphibole asbestos* are found in the serpentine. The former has been described in this BULLETIN (1906, **4**, 206). Cyprus Asbestos Co., Ltd., working at Amiandos, has an up-to-date installation, designed for an ultimate capacity of 12,000 tons per annum, and an 18-mile aerial ropeway to convey the ore to the sea near Limassol. The exports from the Amiandos field from 1913 to 1921 inclusive amounted to 8,225 long tons. No regular mining of amphibole asbestos has yet been attempted. The serpentine also contains *magnesite*. In the Akamas Peninsula this is found at and near the contact of serpentine and limestone. Near Kephalovrysia especially, irregular veins, stockworks and concretionary nodules of magnesite occur. A sample gave the following percentages : magnesium carbonate, 94·00, carbonate of lime, 4·55 ; silica and insoluble

matter, 0·98; iron oxide and alumina, 0·18; moisture, 0·18. In certain parts of the island, *terre verte* is found among the volcanic rocks, and has value as a pigment. It has already been described in this BULLETIN (1906, 4, 210). *Clays* are used locally for making pottery, and the dolerite (diabase) makes excellent road metal.

The economic rocks and minerals of the Pliocene and Pleistocene include *building-stone* (calcareous freestones and sandstones), *road metal* (igneous pebbles and boulders of the coarse conglomerates), and *salt*. The deposit of salt, which is Government property, has already been described in this BULLETIN (1916, **14**, 37).

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India and the Tropics generally. It must be understood that the Imperial Institute accepts no responsibility for the opinions expressed in the papers and reports summarised.

AGRICULTURE

FOODSTUFFS

Sugar.—A paper on "The Beet Sugar Industry," by W. L. Williams, Manager of the Maffra Sugar Factory, has been printed in *Journ. Dept. Agric., Victoria* (1924, **22**, 321). The Maffra factory in Victoria was opened in 1897 but after two manufacturing seasons it was forced to close owing to financial difficulties. The Government later took over control and in 1910 the factory opened on experimental lines and from 1912 onwards it was conducted as a commercial enterprise. By 1915, after allowing for interest and depreciation, losses had been experienced amounting to £20,000, but since that time conditions and results have been much more favourable. The losses have now been cleared off and a profit obtained of £33,477, after allowing £33,852 for interest and £28,129 for depreciation. Such a result on so small a turnover is considered by Mr. Williams to be very promising, and he points out that the chief value of the industry is in giving employment and profit to the district in which it is located. The method of beet cultivation is briefly described and costs of production, together with costs of manufacture,

are given. It is considered that the beet industry promotes closer settlement, intensive culture and increased production and wealth, and opens up valuable avenues for labour in country districts, while the by-products are of value for stock-feeding. The industry is recommended as a desirable asset for the Southern States, but caution should be adopted in introducing it into a new district.

Tea.—The *Quarterly Journ., Scientific Dept., Indian Tea Assoc.* (1924, Part II, p. 91) contains a record of trials with nitrogenous manures on tea. These trials have now been in progress for four years on 18 plots of "Matelli" jat, planted with one-year seedlings in 1916, collar pruned in 1918, left unpruned in 1919, and plucked from 1919 until May 1920 for initial fertility records.

An article on this series of experiments appeared previously in the same *Journal* (1921, Part I, p. 10). The first dressings of manures were applied in 1920, and further applications were made in 1922 and 1923, the year 1921 serving to test the residual effect of the 1920 manuring. The percentage increase of pucca tea produced during the four years for each type of manuring over that from the check plots is as follows: nitrate of soda 18·07, green manure 9·31, oilcake 8·81, sulphate of ammonia 5·75. The use of sinews as manure resulted in a decrease of 0·32 per cent. All plots received equal dressings of bone dust in 1922 and 1923, the phosphorus content of oilcake and sinews having been disregarded after 1920. The nitrogenous manures were applied annually, except in 1921, at rates calculated to give 30 lb. more nitrogen per acre than that in the bone dust applied to the check plots. The monthly yields together with details of the weather and other factors are recorded.

Maize.—The quality and marketing of maize for export are discussed in *Rhodesia Agric. Journ.* (1924, **21**, 283). In 1923 Rhodesia produced one and a half million bags of maize, of which nearly one million were exported. It is stated that Southern Rhodesia produces white flat maize superior in quality to that of her immediate neighbours. This is chiefly due to better methods of cultivation, to the practice of seed selection, and to the exclusive use of white varieties in the main producing areas. The white flat maize grown in Rhodesia is regarded as the best of that type. It is a significant and satisfactory fact that throughout the export year of 1923 Rhodesian maize sold at a premium of 1*s.* 6*d.* per quarter over the average price of Argentine maize. It is pointed out that the simul-

taneous cultivation of white and yellow varieties, combined with indifferent seed selection, tends to produce a rapid deterioration in quality, and that the aim of Rhodesia should be the steady production of maize of high grade. The article deals with threshing, damp and split grain and defectives, and the general handling and bagging of maize. Grading regulations and definitions of grades are also given.

OILS AND OIL SEEDS

Chinese Wood Oil.—Two bulletins have recently been published in the United States dealing with Chinese wood oil (tung oil). The earlier of these (*Dept. Comm., U.S.A., Misc. Series*, No. 125, 1923) is concerned with the present situation in China together with the factors tending to restrict trade in the oil and cause undue fluctuations in the price. After emphasising the dependence of the United States on Chinese production for their supplies, the bulletin describes the Chinese wood oil tree and its cultivation in China. An account of the preparation of the oil and a description of the native press follow. The oil is stated to be collected from the small mill-owners by agents and forwarded to dealers, who generally clarify it either by exposure or by heating. The clarified oil is then shipped by the Yangtze River to Hankow whence 90 per cent. of the total exports of tung oil are distributed, Shanghai and Hong Kong being next in importance. The oil was formerly shipped in oak barrels but shipment in bulk is more general at the present time. The high insurance rates for cargoes on the Yangtze River, losses through piracy, and the taxes levied are all responsible for the high price of the oil. Chinese wood oil has sometimes been heavily adulterated with tallow, sesame oil and tea seed oil.

Of the 44,379 tons of China wood oil exported from China in 1922, 37,337 tons went to the United States, 2,283 tons to Germany, 1,901 tons to Spain, and 1,053 tons to Great Britain. For the first nine months of 1923, the United States imported 32,685 tons.

It is considered that prospects of increased production of the oil and a lower and more steady price are not hopeful. Little progress is likely to be made in the near future in extending the cultivation on scientific lines or in producing the oil by modern machinery. In one or two sections, however, attempts have been made to cultivate the tree scientifically. The introduction of machinery for use by natives, whereby large waste of oil would be avoided, does not appear probable owing to the con-

servatism of the native mill-owners. One firm made a serious attempt to install presses at Hankow but was not successful. The working of mills, equipped with modern machinery, and erected at convenient centres, would mean the elimination of hundreds of small mill-owners and a loss of means of livelihood to many natives. The prospects of the Chinese wood oil industry in China could be considerably improved if foreign firms entered the field and exercised control, but this is not possible as foreigners are not allowed to operate in the interior of China.

It is therefore concluded that the best course for Americans to adopt is to cultivate the tung tree in the United States and thereby make themselves less dependent on foreign countries for their supplies. With this end in view the last few pages of the bulletin are devoted to an account of the cultivation of the tree in the United States.

The second of the bulletins dealing with this subject is a "Preliminary Report on Experiments with the Tung Oil Tree in Florida" (*Univ. Florida, Agric. Exper. Stn.*, 1924, *Bull.* 171). This bulletin is well illustrated, and, in addition to a certain amount of information abstracted from the above *Department of Commerce Bulletin*, it contains a description of the tree (*Aleurites Fordii*) and the results of investigations at the Florida Experiment Station. One of these experiments was undertaken to ascertain the effect of fertilisers. In 1922 a four-acre grove of seedlings was planted on sandy soil and was treated during the winters of successive years with various combinations of fertilisers, the same tree being always given the same combination. So far no varying effects from the different fertilisers have been noted. Further plantings were made in January and December of last year in continuation of this experiment and also in order to note the effects of cutting back in different ways when planting.

The results obtained at this station have shown that good yields can be produced in Florida and that young trees can be grown in nurseries with relative ease. In view of these facts, large areas have now been planted by a company at Gainesville (see this BULLETIN, 1924, 22, 60).

Experience has shown that February is the best month for sowing and that the seeds should be planted at a depth of 2½ in., from 8 to 12 in. apart, in rows 3 feet distant from each other. The application of a well-balanced fertiliser in the early season is recommended and the use of barnyard manure has been found to hasten the growth of young trees. In addition to paragraphs on transplanting,

cultivation, soils, fertilisers and harvesting, notes are given on a root parasite, the nematode (*Heterodera radicicola*) which causes root-knot, and two species of scale insects, the cottony cushion scale (*Icerya purchasi*) and latania scale (*Aspidiotus lataniæ*), all of which have been found attacking tung oil trees in Florida.

Coconuts.—France is at present dependent on foreign countries for her supplies of copra and coconut oil, but there is plenty of land available in her possession of Indo-China which could be profitably used for the cultivation of the palm (*Bull. Econ. Indo-Chine*, 1924, **27**, No. 165, p. 137; and No. 166, p. 269). In this article an account is given of the cultivation and production of coconuts in Indo-China together with a description of the modern European methods. Coconut cultivation is generally considered as an accessory industry in Indo-China, except in the provinces of My-tho, Bentré and Bongson, where the natives live entirely on the profits drawn from this source. After reviewing the obstacles that prevent an extension of the industry, recommendations are made as to means whereby the output of coconut products might be increased. Among these is the proposal that an experiment station should be created, either in My-tho or Bentré, where work could be carried out on the varieties of the palm, manuring and cultivation, the methods of drying copra, and the control of pests.

Linseed.—A recent *Memoir of the Department of Agriculture, India* (1924, **12**, No. 4), is devoted to a study of Indian linseed. Seeds of the various grades of commercial linseed and of a few varieties grown in the Pusa district and on Indian Government farms were sown in Pusa in 1915. By means of selection, carried out each year, elementary species have been obtained. These have been studied and classified; the question of pollination has been examined in detail and the amount of natural crossing determined. Attention has also been paid to the root system, to the effect of soil conditions on growth, and to the economic aspect. As a result some promising types have been isolated.

Great differences have been observed between the types of linseed grown on the soils of Peninsular India (south of the line of the Ganges and the Jumna) and those cultivated on the Gangetic alluvium. The former types are characterised by a very deep root development and large seeds, rich in oil, while the latter have usually

a shallow and abundant root system and produce numerous seeds which are generally smaller and less rich in oil than those of the Peninsular types.

As regards the effect of changes of soil conditions on the growth of linseed, experiments, lasting over a period of three years, have shown that the addition of aerating material to the soil caused a small increase in the height of the plant and in the number of branches, an increase roughly equivalent to that produced by sodium nitrate. Sodium nitrate, however, had a much greater effect on the yield of seed. The addition of organic matter, either alone or with aerating material, produced a more pronounced result, the addition of 30 per cent. of leaf-mould giving an increase of approximately 30 per cent. in the height, 100 per cent. in the number of basal branches and 250 per cent. in the weight of seed yielded.

Sections of this *Memoir* are devoted to the biology of the flower, including pollination and cross-fertilisation and to the classification and description of the types.

In connection with the economic aspect, it is stated that the commercial classification of Indian linseed is based on the size and colour of the seed. Three sizes are recognised: bold, medium and small, and two colours: yellow and brown. The value of the seeds depends on their oil content, but other things being equal, the larger seeds command the higher price. From determinations carried out on seed grown at Pusa, it appears evident that there is a certain correlation between the size of the seed and its oil-content, the larger seed giving the higher percentage of oil. It therefore seems desirable to cultivate the large-seeded type, if seed possessing a high oil-content is desired. The yield of seed per acre must, however, also be taken into account as well as the oil-content when the merits of the various types are being compared. Opinions differ as regards the relative values of yellow and brown seed; in some quarters the pale variety is considered more valuable, while in the United Kingdom the brown seed is preferred.

All types of linseed with bold seed (rich in oil) belong to Peninsular India and trials have shown that they will not thrive in the alluvium (the Punjab being a possible exception). Seeds of the bold-seeded types isolated in this investigation have been tried in the Central Provinces and in some cases have given very promising results. As regards the introduction of improved varieties for the alluvium, trials have been carried out during the last three years at Pusa with some of the more promising types and have resulted in a yield of 11½ maunds per

acre against 7½ maunds per acre for the variety usually grown.

Experiments are now in progress to ascertain whether it is possible to produce by hybridisation a bold-seeded variety suitable for the United Provinces and Bihar and giving a high yield of seed.

Palm Oil.—In continuation of the investigations carried out by the Agricultural Department, Nigeria, reviewed in this BULLETIN (1924, **22**, 214), further work has been undertaken and the results are described in a *Special Bulletin of the Agricultural Department, Nigeria* (April 1924). An investigation on the occurrence of free fatty acids in palm oil has led to the following conclusions. Bunches of ripe fruits may be stored under cool, dry, well-ventilated conditions for from 7 to 9 days without seriously affecting the acidity of the palm oil. Fruits, especially unripe ones, removed forcibly from the bunch, exhibit a greater rate of increase in the acidity of the palm oil than those allowed to separate naturally. The enzymes secreted by growing moulds are capable of hydrolysing the palm oil, while commercial palm oil, containing active enzyme, continues to become more acid during storage. Hydrolysis is reduced by the removal of extraneous vegetable matter from palm oil and is entirely prevented by heating the oil to 110° C. and filtering. The action of the enzyme in the pericarp can be completely inhibited by heating the fruit for 10 minutes in water at 55° C. and can also be modified by the action of certain chemical agents.

A modified process for the preparation of palm oil by natives is outlined, the adoption of which would result in a saving of some of the oil now wasted and in the production of an oil of a quality superior to that of the average "soft" oil now marketed. According to this method, the bunches are stored until the fruits drop out on vigorous shaking. The fruits thus obtained, after being screened or winnowed to remove leafy or woody portions and dirt, are steamed for 30 minutes and then stored for 18–24 hours. These fruits are then mashed in a type of canoe, stored for 24 hours with a channel and covering, and then mashed again, as is done in the hard oil process (see this BULLETIN, 1924, **22**, 214). After a further storage for 24 hours, the mass is submitted to hot water extraction, followed by cold water extraction and the usual operations for separating the oil. Further investigation of this method is being carried out.

In connection with an account of the factory extrac-

tion of palm oil, experiments are described which show that the centrifugal system of extracting palm oil is the best known at present. The essential factors for the success of this method appear to be: the use of ripe fruits only; thorough cooking of the fruits; the use of steam-jacketed high-speed centrifugals, fitted with a jet through which hot water and steam can be blown on to the rotating mass of fruits; and a suitable arrangement for keeping the gauze lining of the centrifugal basket clean.

The treatment of palm nuts and kernels to facilitate the separation of the kernels in an undamaged condition and to prevent the development of undue acidity in the kernel oil is dealt with in the later pages of the bulletin. Sir Hugh Clifford, G.C.M.G., the Governor of Nigeria, in a foreword to this *Special Bulletin* says that the only remedy to prevent the immense annual loss of palm oil and to enable the forest-grown palm produce to compete on equal terms with that of European-owned plantations lies in the construction of central factories equipped with modern machinery and worked on scientific principles.

Fibres

Hibiscus cannabinus.—The results of a series of studies of *Hibiscus cannabinus*, the source of the fibre known as Bimlipatam jute, Ambari hemp or Gambo hemp, have been given by Willem Adolf Horst in *Faserforschung* (1924, **4**, 61). The paper deals in a comprehensive manner with this fibre in comparison with jute and allied fibres, gives particulars of its structure, microchemistry and microphysics, and discusses its chemical composition and behaviour and its bleaching properties. The estimation of the fibre content of the stems is also dealt with, and information is supplied relating to the cultivation of the plant. The work has been carefully written and is illustrated by several coloured plates representing different varieties of the plant and two plates of microphotographs showing the structure of the stem.

Among the author's conclusions the following points may be mentioned: The flowers are mainly self-fertilised; the length of the fibre is somewhat greater than that of jute; the ultimate fibres are somewhat longer, broader and more thick-walled than those of jute and show certain differences at their ends; the Hibiscus fibre is rather less lignified than jute but its yields of water, ash and cellulose are about the same as in the case of the latter fibre; the stem of the variety "green III" gives about one-third of its weight of bark which contains from 30 to 50 per cent. of fibre.

Cotton

Australia.—In the last issue of this BULLETIN (1924, 22, 362) reference was made to the action of the Queensland Government in connection with the cultivation of cotton as a ratoon crop. It is now stated in the *Queensland Agric. Journ.* (1924, 22, 61) that the Government has decided, pending the passing of amending legislation, not to enforce the provisions of the Cotton Industry Act prohibiting cotton ratooning. In making this announcement the Minister for Agriculture made it clear that growers would be allowed to ratoon the current year's annual cotton, provided the shrubs were cut back to 6 in. above the ground before September 15. Permission to ratoon applied only to annual plants, and therefore all ratoon plants then in existence had to be totally destroyed. The cultivation of second ratoons was absolutely prohibited. Pruning had to be completed by September 15, and growers intending to ratoon the current season's plants were to notify the Department immediately. Cuttings accumulated in the process of ratooning, together with all other cotton-field debris, were to be totally destroyed by fire by the same date. This also applied to cotton plants which growers did not intend to ratoon.

It is not proposed by the Government that the relaxation of the ratooning restrictions shall mean that cotton shall not continue to be subject to a "close season." The necessity of keeping cotton fields thoroughly clean as a precaution against pests cannot be ignored. The Government guarantee will not apply to ratoon cotton in 1925, but it may be ginned at authorised ginneries. It has been decided to gin and market ratoon cotton separately, and if, after meeting all charges, there is any surplus above the amount advanced against the consignment on its receipt at the ginnery, as with annual cotton, it will be returned *pro rata* to the suppliers. Ratoon cotton must be harvested and bagged separately. The bags must be labelled "Ratoon." The mixing of annual and ratoon cotton in one container is absolutely forbidden, and heavy penalties are provided for anyone found guilty of so doing.

Insistence will be made on the observance of the existing stipulation that all seed for cotton-growing must be obtained through the Department of Agriculture. Legislative provision for the registration of cotton growers already exists, and this provision will be strengthened in the amending Bill to be introduced this session by making the possession of a licence by the grower essential.

Rhodesia.—Renewed interest in cotton growing is being evinced by the Rhodesian farmers, and in this connection the following information has been published in the *Rhodesia Agric. Journ.* (1924, **21**, 119, 399).

Trials were made in 1919–20 in several districts on plots ranging from 1 acre to 50 acres, and while in some cases satisfactory yields were obtained, in others, total failure resulted. The cotton produced. was favourably reported on by British brokers and manufacturers, but the enterprise was not continued owing to the high cost of transport and the lack of suitable machinery for preparing the lint for the market.

During the present year, the farmers have been led to make further efforts in view of the high prices ruling for cotton and the removal of transport difficulties. The Government has encouraged the movement, and great assistance has been afforded by private enterprise in supplying seed and manures and establishing a ginnery at Salisbury to deal with the crop.

The Tobacco and Cotton Expert reports that about 55 tons of seed have been imported and distributed. The districts in which most of the seed has been planted are Mazoe, Hartley, Lomagundi, Bubi and Nyamandhlovu, whilst many experimental plantings have been made in the Makoni, Salisbury, Bulawayo, Victoria and Umtali districts. Seed has also been distributed to natives through the Native Affairs Department for trial in the Umtali and Darwin districts.

It is estimated that at least 8,000 acres have been planted this year (1924) as compared with 21 acres in 1923.

Paper-making Materials

Woods from French West Africa.—In this BULLETIN (1924, **22**, 230) reference was made to a study of the wood of *Triplochiton Johnsoni* as a paper-making material by Prof. F. Heim, in collaboration with J. Maheu, M. Cercelet, G. S. Dagand and R. Heim de Balsac. More recently reports have appeared of investigations by the same workers of five other West African woods.

1. "Sibo" wood (*Sarcocephalus esculentus*, Afzel.) from the Ivory Coast (*Bull. de l'Agence Gén. des Col.*, 1923, **16**, 1232).

This wood contained 8·76 per cent. of moisture; on chemical examination it yielded 0·20 per cent. of ash, 0·96 per cent. of fats and waxes, 67·48 per cent. of cellulose, and 31·36 per cent. of lignone (calculated on the dry material). On digestion with caustic soda under pressure,

a yellowish-brown pulp was obtained which bleached with difficulty to a pale yellowish colour. The yield of bleached pulp was 33 per cent. (expressed on the dry material). On microscopical examination, the pulp was found to be fairly homogeneous and to consist of fibres, together with some cells and fragments of vessels. The fibres vary in length from 1 to 2 mm. with an average of 1·4 mm., and have a diameter of 15–35 μ with an average of 25 μ, the felting power (diameter: length) being 0·018. Paper made from the pulp was of inferior quality and the pulp would only be of service as a filling material.

2. " Fromager " wood (*Eriodendron anfractuosum*, D.C.) from the Gaboon (*Bull. de l'Agence Gén. des Col.*, 1924, **17**, 185).

This wood contained 9·80 per cent. of moisture ; on chemical analysis, it gave 5·90 per cent. of ash (composed of lime 99·5 per cent., and alumina and ferric oxide 0·5 per cent.), 0·62 per cent. of fats and waxes, 68·30 per cent. of cellulose, and 25·18 per cent. of lignone (calculated on the dry material). On treatment with caustic soda under pressure, it furnished a brownish-yellow pulp which was easily bleached to a dull white. The yield of bleached pulp was 30 per cent. (expressed on the dry material). On microscopical examination, the pulp was found to consist of fibres, together with some accessory elements and fragments of vessels and cells. The fibres have a length of 1·0–1·8 mm. with an average of 1·4 mm., and a diameter of 20–30 μ with an average of 25 μ, the felting power (diameter : length) being 0·018. The pulp furnishes paper of an ordinary quality.

3. " Bahia " wood (*Mitragyna macrophylla*, Hiern) from the Gaboon (*Bull. de l'Agence Gén. des Col.*, 1924, **17**, 377).

This wood contained 7·54 per cent. of moisture ; on chemical analysis it yielded 0·77 per cent. of ash, 0·60 per cent. of fats and waxes, 70·0 per cent. of cellulose, and 28·62 per cent. of lignone (calculated on the dry material). On digestion with caustic soda under pressure, a bright brownish-yellow pulp was obtained which bleached with average facility to white with a slight greenish-yellow tint. The yield of bleached pulp was 33 per cent. (expressed on the dry material). On microscopical examination, the pulp was found to consist of fairly homogeneous fibres, 1·2–2·7 mm. long with an average length of 1·7 mm., and 15–35 μ in diameter with an average diameter of 25 μ ; the felting power is 0·015. The pulp gives a paper of similar quality to ordinary wood-pulp papers.

4. "Pri" wood (*Funtumia africana*, Stapf) from the Ivory Coast (*Bull. de l'Agence Gén. des Col.*, 1924, **17**, 561).

This wood contained 8·40 per cent. of moisture; on chemical analysis, it gave 0·98 per cent. of ash, 0·63 per cent. of fats and waxes, 65 per cent. of cellulose, and 33·39 per cent. of lignone (calculated on the dry material). On treatment with caustic soda under pressure, a bright brownish-yellow pulp was produced which bleached with some difficulty to a creamy-white. The yield of bleached pulp was 32 per cent. (expressed on the dry material). On microscopical examination, the pulp was found to consist of fibres, together with occasional parenchymatous cells and some fragments of vessels. The fibres are 0·7–1·5 mm. long, with an average length of 1·2 mm., and have a diameter ranging from 15 μ to 35 μ with an average of 25 μ; the felting power is 0·02. The pulp furnishes paper of a satisfactory quality and comparable with ordinary wood-pulp paper.

5. "Ako" wood (*Antiaris africana*, Engler) from the Ivory Coast (*Bull. de l'Agence Gén. des Col.*, 1924, **17**, 733).

This wood contained 7·96 per cent. of moisture; on chemical analysis, it gave 1·57 per cent. of ash, 0·54 per cent. of fats and waxes, 65 per cent. of cellulose, and 32·89 per cent. of lignone (calculated on the dry material). On digestion with caustic soda under pressure, a brownish-yellow pulp was produced which bleached fairly easily. The yield of bleached pulp was 32 per cent. (expressed on the dry material). On microscopical examination, the pulp was found to consist of fibres, together with some parenchymatous cells and fragments of vessels. The fibres are 0·8–1·3 mm. long, and have a diameter ranging from 15μ to 30μ, with an average of 25μ; the felting power is 0·02. The pulp furnishes an ordinary paper of satisfactory quality.

MINERALS

Abrasive Garnet

United States.—There is a detailed description of the quarries and operations of the North River Garnet Company in the Adirondack Mountains, Warren County, N.Y., in *Eng. and Min. Journ.-Press*, Oct. 4, 1924. This is the greatest garnet-producing enterprise in the United States, its output being from 4,000 to 6,000 tons per annum. The garnet is a specially hard variety of almandine (iron-alumina garnet) contained in garnetiferous gneiss (a metamorphosed sediment of the Grenville series)

in which it is associated chiefly with hornblende, felspar, and a little pyrites. Individual crystals average about ½ inch in diameter but sometimes reach as much as 4 inches. The great difficulty in concentration is the separation of hornblende from garnet, owing to the similarity of their specific gravities. After stage crushing with jaw crushers and rolls, this is accomplished by means of an elaborate system of jigs of various designs, some of which were specially devised for the purpose. Experiments made with electrostatic methods of concentration were not encouraging. Only one grade of product is marketed, a mixture of all the sizes of garnet produced, but this is of very constant mechanical composition and contains about 90 per cent. of garnet. A small amount was used by jewellers during the late war for watch pivots, owing to the scarcity of rubies, but the whole output now goes to abrasive manufacturers for the preparation of garnet-paper, which in certain industries is much preferred to common "sand"-paper. The only rival to American garnet in the world's market is Spanish alluvial garnet, and of the latter the deposits are said to be almost exhausted.

[It should be noted that the British Empire, except for minor amounts produced in India and a new enterprise projected in Canada, is entirely dependent on foreign sources of supply for this comparatively common, useful mineral.]

Bauxite

Gold Coast.—In the *Report* of the *Director of the Gold Coast Geological Survey* for the 15 months ended March 31, 1923, reference is made to shaft-sinking work carried out by the Survey with a view to testing further the deposits of bauxite on Mount Supirri, Atruinso, described in the *Report* for 1921. Full details of the results of this work are to be published in a special report, but it is remarked than one shaft sunk to a depth of 52 ft. was entirely in bauxitic material.

Discoveries of bauxite in the neighbourhood of Akkapurusu; at Yangkumassi; and near Pomporo are reported, but whether they are payable has not been proved. Two discoveries of some importance, however, were made, one at Angwinyare Bopa, E.N.E. of Aboabo, with an estimate of 965,000 tons of bauxite, and another at Sumanchichi Bopa, near Abworso on the Ashanti boundary, with more than 200,000 tons of bauxite. The average of 9 samples taken from different parts of the hill in which it occurs showed the percentage composition to

be as follows: silica, 0·59; alumina, 53·20; ferric oxide, 15·52; titanium dioxide, 0·89; lime, 0·21; magnesia, 0·07; vanadium sesquioxide, 0·04; and water, 29·46.

Between Mafia and the old Akaso mine, bauxite was noted on a laterite-capped ridge, and also south of Okuasi, which includes some of good quality, but not in great quantity. Blocks of bauxite were observed at Tettiaso, and bauxite pebbles between Infaka Infuhu and Abworso. Near Awuakrom near Abori, in the Ofin River region, blocks of bauxite were found, and in the hills between Bibiani and Asempanya, a large amount of bauxite, some of good quality, is present in scattered remnants of a denuded area, but the deposit is probably not comparable in extent with those found at Mounts Ejuanema, Supirri and Ichinniso.

Between Asempanya and Pomakrom much loose bauxite was observed, and also the remnants of a former capping of bauxite. However the range is too dissected for extensive deposits to have been preserved.

Bentonite

Canada.—According to the *Eng. and Min. Journ.-Press*, July 26, 1924, the Mines Branch, Canada, has found a new use for bentonite. A commercial enterprise desired to grind lump asphalt to a powder for use in waterproofing paper-board. When ground alone, the fine particles adhered to one another, and this difficulty was not successfully overcome by adding clay or talc to the asphalt. Since bentonite was known to assist in forming water-suspensions of enamels and to be capable of forming an emulsion with asphalt, it was applied to the above problem with results which showed that an exceedingly smooth, stable paste suitable for incorporating into felt, paper or other materials, could be produced. An addition of 20 per cent. of bentonite in the wet grinding of asphalt assists materially in the production of a fine, uniform product. Both Canadian and American bentonites were used, but no material differences were noticed in the results.

Coal

Nigeria.—According to the *Administrative Report of the Nigerian Railway and Udi Coal Mines* for the year ended March 31, 1924, the output of the Udi collieries for the period under review amounted to 175,137 tons, or 62,317 more than that of 1922–23. The total quantity of coal produced to date, i.e. since 1916, amounts to 1,105,077 tons, or an average of 138,134 tons per year.

The output for 1924–25 is estimated at over 200,000 tons. The cost of production in 1923–24 was reduced to 6*s*. 8·3*d*. per ton, or practically 3*s*. below that of the previous year. The pits' mouth price of coal was reduced to 10*s*. per ton on April 1, 1923, and in June, 1924, was quoted at 25*s*. a ton f.o.b. Port Harcourt. The employees comprise 27 Europeans and 1,435 natives. Owing to the increased difficulty in obtaining pit props and roofing timber, plantations have been put down near the mines under the supervision of the Forestry Department. The total area planted at the end of March amounted to 36·4 acres, and this is being increased. The trees planted were teak, *Cassia siamea* and casuarina, spaced 6 ft. by 6 ft., which will give a yield of some 6,000 poles per acre before the first thinning.

Canada.—Reference to the coal of the Kootenay formation of Alberta has been made in the Imperial Institute Monograph, *Coal* (1920, p. 97), and in this BULLETIN (1923, **21**, 369). Further particulars with reference to the structural problems of the Crowsnest area of this formation are given by B. Rose in *Canad. Met. Min. and Met. Bull.* 150 (October, 1924, p. 609). The Kootenay formation of this area consists of grey sandstones, dark shales and coal seams 400 to 700 ft. thick, forming the base of the Cretaceous. From 4 to 6 seams are known, the quality of the coal being high-grade bituminous. No. 1 seam lies just beneath the basal conglomerate of the Blairmore formation (overlying the Kootenay), and is mined at Blairmore, Bellevue and Hillcrest. No. 2 seam has been extensively mined at Coleman. Both these are thick seams, but they pinch and swell, from less than 5 ft. up to 15 ft. in thickness. No. 4 seam is approximately 6 ft. in thickness, and is mined at Coleman, and to a small extent at other points. The coal is essentially a steam fuel, and much of it makes good coke. The ash-content varies, as thin shale bands occur here and there in the seams. A great deal of the coal is purchased on a basis of an ash-content of 17 per cent. or less. Sometimes the ash-content is as low as 5 per cent. The following is an average proximate analysis of the commercial coal from the area: moisture, 0·5; volatile combustible matter, 24·5; fixed carbon, 59·0; ash, 16·0 per cent.

The formation outcrops in a N.–S. direction. From Blairmore westward to Coleman, the Kootenay formation is repeated three times by faulting, while eastward from Hillcrest to Burmis it comes to the surface in eleven places, mostly on the limbs of folds. Most of the coal

mined in the Crowsnest area of Alberta is in steeply pitching seams. The main haulage levels are driven along the coal-seams, the coal above is mined by the room and pillar system, and is carried by gravity to the haulage ways. In mining, both small and large thrust-faults and folds, as well as drag-folds or the bending of the rocks close to one of the large fault-planes, have to be taken into account, and when the drag-folds occur the coal seams are apt to be too broken and mashed to be worth mining.

Copper

Canada.—The Britannia mine at Howe Sound, Vancouver, British Columbia, is briefly described in the Imperial Institute Monograph, *Copper Ores* (1923, p. 62). The following particulars are gleaned from an article by Robert Dunn (*Eng. and Min. Journ.-Press*, April 19, 1924, p. 640). From the year 1906 this mine has produced about 66,000 long tons of copper. The new steel-concrete mill of 2,500 tons daily capacity was started in March, 1924, and the concentrate is being shipped to the Tacoma plant of the American Smelting and Refining Co. for reduction. The plant is worked by electric power developed on the property. Mining is by overhand shrinkage stoping.

The sedimentary and igneous rocks at Britannia are an inclusion in the Coast Range granodiorite batholith. There are five ore-bodies in the same shear zone, named, from east to west, Victoria, Empress, Fairview, Bluff and Jane. The Jane, which was the first to be exploited on a commercial scale, is roughly of diamond shape, and is extensively mineralised east and west for 300 ft. and over a width of 250 ft., but no commercial ore has been found below 300 ft. in depth. The Bluff deposit, 900 ft. N.E. of the Jane, has, on the 1,200-foot level, a maximum length, east and west, of 500 ft., and a width, north and south, of 250 ft., and extends to a known depth of 1,600 ft. The Fairview, to the east, is 1,500 ft. long and 500 ft. wide with a known depth of 2,200 ft. East of the last is the Empress with an ore-body 1,000 ft. long and 100 ft. wide. The dimensions of the Victoria, still farther east, have not yet been fully determined.

The mineralisation of these ore-bodies consists of pyrite, chalcopyrite, blende and galena with scattered gold and silver contents. Chalcocite ore occurs in the Empress deposit.

Gold

Southern Rhodesia.—An interim report on the geology of the country south of Umsweswe, Hartley District,

Southern Rhodesia, has been prepared by A. M. Macgregor (*Southern Rhodesia Geol. Survey, Short Rept.*, 16, Aug. 1, 1924).

The output of gold, from the area of about 100 square miles mapped by Macgregor, from 1905 to August 1, 1924, exceeds £650,000 in value. In 1923, gold to the value of £52,776 was produced from 41,806 tons of ore. The biggest producers are the Kanyemba mine with a total production value of £211,720, the What Cheer group of associated ore-bodies with £150,812, and the Revie with £60,273.

The ore-bodies are partly quartz reefs and partly arsenical or pyritic impregnations in schist. The gold mines may be conveniently classed in three groups. In the first group are the mines in the eastern part of the area in granite, or in schist close to the contact. The second group, comprising the Kanyemba and adjoining mines, is characterised by being relatively rich in silver. The third group in the schists near the western granite is chiefly comprised of replacement deposits producing gold comparatively free from silver.

The first group occurs in the Rhodesdale granite, and mostly at the contacts of small inclusions of schist in the granite mass. The Revie and Brompton claims are the largest producers, and comprise about seven quartz bodies with N.N.E. strike and easterly dip. They are arranged in echelon along a belt of country running parallel with the strike of the reefs, and in continuation of the strike of banded ironstone at the contact of the granite north of the Umsweswe River. The ore is generally coarse milky quartz with auriferous pyrite. The Revie is on the contact of the granite with greenstone schists, which here are largely made up of very large blows of quartz. The gold contents are patchy. The ore on the Brompton claims contains much scheelite.

The reefs of the second group are mostly in the basement schists. The quartz vein of the Kanyemba mine is apparently interbedded in highly mineralised schist. The fissure is remarkably curved. The ore-shoot, which is between 200 and 300 ft. long, pitches towards the west. The gangue is a glassy quartz, traversed by minute veins of later quartz. Pyrite occurs especially on the foot-wall, where it is sometimes mixed with pyrrhotite, magnetite and fine-grained cherty quartz. Besides pyrite, arsenopyrite is present in the vein and is sometimes very abundant. Since January 1912, the Kanyemba mine has produced 48,360 oz. of gold and 16,830 oz. of silver from 72,149 tons of ore milled.

The third group is situated in the western part of the area and comprises the What Cheer and Venice mines. The ore-bodies are either quartz veins or impregnations in the basement schists. The fineness of the gold varies from 900 to 941. On the What Cheer mine is a large open working in mineralised andesite-bearing conglomerate. The ore is generally mustard-coloured and rather soft, owing to the development of carbonate minerals with disseminated crystals of pyrite, and in places rather abundant arsenopyrite. The reefs contain much scheelite. A large quantity of ore has been taken out to a depth of 100 ft. Since November, 1907, the What Cheer group has yielded 34,247 oz. of gold and 3,790 oz. of silver from 102,500 tons of ore. The Venice mine, developed to a depth of 300 ft., has produced 4,856 oz. of gold and 301 oz. of silver from 17,694 tons. The ore is arsenical.

Canada.—The newly discovered gold area of Northern Quebec has already been referred to in this BULLETIN (1924, **22**, 88). An article by Sir Stopford Brunton (*Mining Mag.*, Sep. 1924, p. 137) gives some later information with regard to the development of the principal mines of the area. In the Horne claim, the irregular ore-bodies of heavy sulphides are apparently unconnected with one another, and contain no ordinary gangue minerals, such as quartz, calcite or felspar. On this property a total gross value of ore equal to \$7,602,000 has been proved, based on an average vertical depth of 120 ft. The average assay values were for the centre deposit \$26·06; for the west deposit, \$8·50; and for the east deposit, \$15·00 per ton.

On the Chadbourne claim trenches have exposed an area approximately 200 ft. square in which two parallel ore-bearing zones are exposed. A vertical prospecting shaft has been sunk and a small hoist erected on the property.

The shaft on the Lake Fortune telluride and sulphide claims has been sunk to 120 ft., and a cross-cut has been driven 200 ft. north, encountering a payable ore-zone 10 ft. wide. At the Arntfield, trenching has exposed a gold-bearing zone 1,200 ft. in length. This is being examined below surface by diamond drilling.

Drilling operations on the Stabell property have indicated the ore-body to be payable.

H. H. Girvin writes on the geology of the Onaman gold area of Northern Ontario (*Canad. Min. Journ.*, Sept. 12, 1924, p. 899). The area is situated about 20

miles south of Tashota and about 15 miles east of Lake Nipigon. The country rock consists of Keewatin greenstone and Temiskaming conglomerate. The majority of the veins are found in sheared greenstone-schist about ½ mile from the greenstone contact. The veins are of two types ; one with a gangue consisting chiefly of carbonates, and with galena, blende, pyrite, gold and silver. The silver content may be attributed to the dolerite ("diabase") or a basic phase of the young granite. The other type of vein has a gangue of quartz impregnated with auriferous pyrite, and often associated with acid porphyries. Besides the minerals already mentioned, chalcopyrite, native copper in vein quartz, arsenopyrite, erythrite, and a mineral resembling stibnite have been found. On one group of veins, a vein system, striking N.E.–S.W. has been disclosed for a length of 1,600 ft. A mass of quartz-porphyry lies to the north. A new vein system is being uncovered in another group. One vein of a third group has a width of 30 ft. of quartz which is well mineralised with finely disseminated pyrite. Silver ore assaying 12 to 37 oz. per ton has been found in several of the gold-quartz veins. South of Two Mile Lake, gold quartz veins are associated with porphyries in the green schists. Channel samples taken over mining widths from one of these veins gave gold to the value of $4 to $7 per ton.

Japan.—The geology of the Sado gold-silver mine, in Japan, is described by H. Nishihara (*Eng. and Min. Journ.-Press*, July 26, 1924, p. 137). The Sado mine, on Sado Island, is one of the oldest and longest-worked gold mines in the Japanese Empire.

Shale and tuff of Tertiary age trend N.S. and dip W. or N.W. 40°, and are intruded by liparite (post-Tertiary), and covered by andesite flow. The ore-bodies are fissure veins which cut through the Tertiary sediments and are closely related to the liparite intrusion. A mother lode, the Takato vein, trends E.W. for 7,000 ft., and has an average width of 40 ft. It dips S. 70° and is cut by two major faults (A and B, on the west and east respectively). The Odate vein, 1,500 ft. north of the last, runs in a parallel direction for 6,000 ft., and dips S. 60°. Waniguchi is an arched vein splitting off from the hanging-wall of the mother lode. The Takato shaft is 1,255 ft. in depth, and the Odate shaft 1,000 ft. A bonanza is said to have occurred near the surface in a zone between 500 and 800 ft. thick. In the middle portion and west of the A fault, the bonanza was struck at a depth of 300

to 500 ft., the thickness averaging 300 ft. The present workings are on the 1,000-foot level, and the tenor of ore is $5·50 (U.S.) in gold. In the upper zone lamellar quartz pseudomorphs after calcite can be seen. In the 300-ft. level calcite is rare and the vein is enriched with gold and silver. Manganese minerals are rare in the lode. At the bottom of the Takato shaft (1,255 ft.) milky quartz contains dark bands of sulphides, mainly argentite, with protruding particles of electrum embedded in them, while beautiful yellow and bright flakes of gold (secondary) are deposited on or among them. The general pitch of the bonanza is westerly. The enriched part of the ore-body in the western part of the mine carries gold in value $12 (U.S.) per ton, and silver, $7. The Hichisuke vein, which runs diagonally between the Odate and Takato veins, contains a large proportion of blende, galena and chalcopyrite, and has a high silver content.

The Nakao vein, some distance to the west of the above group, consists mainly of quartz in the upper levels, and of quartz, calcite and felspar in the lower levels. The vein is fractured and recemented, forming the ring ore structure. Fragments of the country rock, especially of tuff, in the vein are to some extent silicified and replaced by the ore. The ore minerals include electrum (60 per cent. of gold and 40 per cent. of silver), argentite and pyrite in the upper zone, and chalcopyrite, blende and galena, in addition, in the sulphide zone.

United States.—The gold veins of sundry areas in the Idaho batholith are described by Francis A. Thomson (*Eng. and Min. Journ.-Press*, Oct. 4, 1924, p. 533). The country lying immediately along and outside of the contact of the central granite batholith with the metamorphic and overlying sedimentary rocks is the most important from an economic point of view. The principal mines of the country are along the marginal or peripheral belts, and the roof of the invaded metamorphic rocks overlying the batholith has proved to be the most favourable place for the development of the big gold-bearing quartz veins of the region. These invaded metamorphic rocks from the bottom upwards consist of gneiss, schist and quartzite. Dykes of pegmatite, aplite and lamprophyre appear to bear a close relationship to the gold veins in almost every instance—of these the aplite dykes are the largest and most important. The principal ore deposits are steeply dipping fissure veins carrying principally gold and silver in a quartz gangue. The ore consists of auriferous pyrite disseminated irregularly in the gangue. In places, galena,

chalcopyrite, bornite, and blende are associated with the pyrite. The quartz is of two periods, that of the first being the more massive white variety ("bull" quartz) which consists of a dense vitreous aggregate of interlocking crystals sparsely studded with metallic sulphides. The later "vein" quartz occurs as irregular segregations and lenses in the main quartz vein, with veinlets branching out into the original quartz and into the wall rock. It is of higher grade than the "bull" quartz. At Buffalo Hump, the veins course N.–S. and are 10 to 20 ft. wide. The ore occurs in steeply pitching shoots, often of considerable longitudinal extent. Basic dykes are prevalent. At Elk City, the vein system is fan-like, and the auriferous quartz veins run parallel to aplite dykes, and occur mostly in gneiss. There are basic dykes also in close proximity to the veins.

The development work in this area appears to have been somewhat small hitherto. Thomson concludes that although superficial enrichment played an important part in the region, there are excellent reasons for believing that primary ore of workable grade persists in at least certain parts of the area to depths far below that attained by present workings.

Lead-Zinc

United States.—In the Wrangell district of Eastern Alaska occurs a zinc-lead prospect of an uncommon character, which has been described by A. F. Buddington (*U.S. Geol. Survey, Bull.* 739, 1923, p. 57).

It is in a mineralised belt of metamorphosed rock, 1 to 1½ miles wide, lying between two masses of intrusive quartz-diorite.

The ore veins are found in the mineralised belt for a length of 7½ miles. The main ore-bodies are tabular replacement veins of blende and pyrrhotite in the gneiss, but there are also replacement veins consisting of blende and galena, and veinlets and pockets of the same minerals, but containing pyrite in addition.

The main vein is exposed by surface cuts and natural exposures for a length of about 3,200 ft., and the average of 24 assays, each made on the full width of the vein, ranging from 1½ to 9 ft., is approximately: zinc, 17 per cent.; lead, 2·5 per cent.; and silver, 1·25 oz. per ton. The zinc content ranges from 9·4 to 30·6 per cent.; the lead, from a trace to 12·5 per cent., and the silver from a trace to 4·35 oz. per ton.

Buddington states that high temperature replacement pyrrhotite-blende deposits are not common, and that

those most closely resembling the Alaskan occurrence appear to be the zinc deposits of Ammeberg, Sweden.

Manganese

Union of South Africa.—According to the *South African Mining and Engineering Journal* (Sept. 6, 1924, 1444) a new discovery of manganese ore has been made in the Waterberg district of the Transvaal. The formation is chiefly sandstone and felsite in close association with a lode of specular hæmatite and magnetite iron ores.

The deposit has been traced a distance of about 40 miles from near Naboomspruit to Warmbaths following a line almost N.E.–S.W. and approximating closely to the line of the recently discovered platinum lodes of that region. The outcrop of manganiferous material is very well-defined throughout. The deposit is in the form of a lode with a width of 6 ft. in places, but sometimes dividing into two or more sections with sandstone partings. A French financial group is reported to be interesting itself in this deposit.

So far the output of manganese ore from the Union has been insignificant, amounting in all to only a few thousand tons, but optimism is expressed regarding future production.

Georgia.—The manganese deposits of this Republic are described in the Imperial Institute Monograph, *Manganese Ores* (1919, p. 74). The following information abstracted by the *Iron and Coal Trades Review* (Oct. 10, 1924) from an article by J. Ferfer in *Stahl und Eisen* throws light on the manganese industry in that country.

In 1913 the quantity of ore produced amounted to nearly one-half of the world's production.

Production had practically ceased before the revolution, but has since partially regained its former importance with an output of 360,056 tons for 1923. This compares with a production of 739,888 tons in India and 235,831 tons in Brazil for the same year.

The manganese ore reserves of Georgia are probably the largest in the world. The district of Tshiaturi alone is considered capable of maintaining an output of a million tons yearly for 130 years, while there are other deposits not yet exploited, which bring the total estimated reserves to 214,500,000 tons. It is calculated that an annual production of 2 million tons is possible, which is sufficient for the requirements of the whole world.

The ore producers of several nationalities have formed an association which, it is claimed, has had favourable

results on the industry. The export of ore, however, is a monopoly of the Georgian Government, exercised through a syndicate known as the Temo Co., which has its headquarters at Tiflis and a branch at The Hague.

Inadequate transport facilities are said to be hindering the full development of the industry, and for export the only sea way—through the Bosphorus and the Dardanelles—is liable to be blockaded in the event of war. The construction of a Rhine-Maine-Danube canal system is proposed to obviate this risk.

Nickel

United States.—A nickel prospect in the lower Copper River valley in the Chitina district of Alaska was investigated in 1918 by R. M. Overbeck (*U.S. Geol. Survey, Bull.* 712, 1920). The ore occurrence is in a coarse-grained peridotite, intrusive in quartzose schist and strongly mineralised in places with sulphides. The only mineral definitely identified was chalcopyrite, but analyses proved the presence of nickel.

The best assay result obtained from the Copper River valley deposit showed 11 per cent. of nickel and 2 oz. of silver per ton, and a selected specimen of the sulphide ore analysed in the laboratory of the United States Geological Survey contained 7·23 per cent. of nickel and a trace of cobalt.

The amount of development work done is too small to permit ore reserves to be estimated. The nearest seaport is at Cordova, the terminus of the Copper River Valley railway, 130 miles distant from Chitina.

In *Economic Geology* (1924, **19**, 524), A. F. Buddington refers to this occurrence and identifies the nickel mineral as " bravoite," a mineral first discovered in specimens from the vanadium deposits at Minasragra, Peru, the formula for which is considered to be (Ni Fe)S_2. W. F. Hillebrand considers that the Peruvian mineral must be regarded as a nickeliferous pyrite. Bravoite is named after José J. Bravo, a Peruvian writer on the Minasragra vanadium deposits.

Petroleum

Madagascar.—The oil deposits in the Betsiriry and Sakalava valleys in Western Madagascar are briefly referred to in the Imperial Institute Monograph, *Petroleum* (1921, p. 65). The geology of the bituminous deposits of Madagascar, between Betsiboka and Tsiribihina, is described by Léon Bertrand (*Chemie et Industrie*, 1924, **11**,

783). The bituminous deposits occur in Triassic sandstones, which are exposed at surface from Bongo Lava to Bemaraha, and, west of that point, are covered by Jurassic limestones and marls to Bepea, from which point westward unconformable Cretaceous rocks appear at surface. The bituminous sandstones, impregnated with about 10 per cent. of hydrocarbons, do not occupy a definite zone in the Triassic series but are usually more or less lenticular in shape and irregularly distributed therein. However, in particularly favourable regions, like the "Pentagoné" of Driez, in the Bemolang concession, several bituminous beds, sensibly horizontal and superposed at certain distances above one another, are exposed along the ravines. These deposits are the residue of ancient deposits of petroleum, which have lost their most volatile hydrocarbons and have been exposed to oxidation and resinification in the superficial zone in which they occur. There exist important oil indications at numerous points between Manambaó and Manambolo, and in the region of Sambirano, near the northern extremity of the island, and petroleum should be looked for where the Trias is covered by more recent rocks, and where, consequently, the more volatile hydrocarbons are more likely to have been conserved.

According to Jean A. Hardel (*Chemie et Industrie*, 1924, **11**, 1003), the exploitation of the bituminous sandstones of Madagascar, although an interesting problem, will need great efforts and prolonged study before it is likely to be brought to a successful issue. The principal deposits are to the east of Horafénobé. Bituminous sandstones are seen in the bed of the River Ranobé, and in that of the Besahena, one of its affluents, but the most impregnated zone is farther south in the Manambaó Basin. In this zone petroleum indications are met with over nearly 200 sq. miles. Above the stream beds, the thickness of the bituminous sandstone is 33 to 39 ft., and, in certain spots, pits have been put down from 50 to 65 ft. in depth without meeting with sterile rock. However, the thickness is very varied, and, along the outcrops, the bituminous content is very irregular. The economic value of the deposits can only be ascertained by systematic sampling and analysis.

Phosphates

New Caledonia.—The phosphate deposits of Walpole Island (lat. 22½° S.; long. 168½° E.), a dependency of New Caledonia in the South Pacific Ocean, are the subject of

an article by A. M. Wright in *New Zealand Journ. Sci. and Tech.* (July 1924, p. 91). The island, which has a surface area of 300 acres and rises to an altitude of 230 ft. above the sea, is under French administration, but is leased to an Australian firm which controls the output of guano and phosphate from this and other islands in the vicinity.

The chocolate-coloured phosphate occurs as loose, earthy material in depressions amongst the coral rock of which the isle is composed, and these vary in depth from a few inches to 20 ft., averaging about 30 in. After digging, the material is dried in the sun or, in the wet season, in steam-heated vacuum pans, and after crushing and screening, it is bagged and shipped by means of lighters. A composite sample representing a very large bulk was found to contain tricalcium phosphate 52·37 per cent., water 11·71 per cent., organic matter 11·39 per cent., with smaller amounts of iron and aluminium phosphates and other substances. A number of tests to ascertain the solubility of the phosphate in a 2 per cent. citric acid solution were carried out and showed a considerably greater solubility than did samples from Nauru. If therefore this test can be relied on to show the "available" phosphorus in a phosphatic manure, the Walpole Island phosphate is agriculturally probably the most valuable untreated phosphatic fertiliser imported into New Zealand.

Silver

Canada.—The Premier silver mine of Northern British Columbia has already been described in this BULLETIN (1921, **19**, 106, 424; 1923, **21**, 545). C. A. Banks (*Mining Mag.*, Sept. 1924, p. 149) gives an account of the development of the gold-silver ore-bodies found in the property of the B.C. Silver Mines, Ltd., adjoining the Premier.

The easterly continuation of the Premier ore-zone has been proved in the B.C. Silver Mines for a length of 1,000 ft. The ore occurs in a shear-zone striking N. 50° E. and dipping N.W. 60° to 80° in porphyry and tuff, and is more mineralised in the former than in the latter. The ore occurs in shoots within the silicified portions of the shear-zone which pitch S.W. 60°. The ore-zone is cut by a number of lamprophyre dykes from a few inches to 10 ft. in width, striking N.W. and dipping S.W. 60°. There is heavy enrichment along slips and faults to a vertical depth of 700 to 800 ft. At No. 3 level, which is about 300 ft. from surface, the lode has been driven on for 1,050 ft. Near the Premier boundary an ore-shoot is being developed having a total width of 40 ft., and for 15 ft.

carrying $35 ore. This shoot has since been found to extend 300 ft. into the Premier ground. In the No. 3 level of the B.C. Silver Mines ore of commercial grade was not found after the first 75 ft. going east. In the shoot itself, as proved by a rise, the mineral contents are erratic; some picked samples run as high as 50 oz. of gold and 260 oz. of silver per ton. Native and ruby silver are fairly common and much of the pyrite is comparatively rich in gold.

The ore on the Premier and B.C. Silver, as disclosed to date, occurs mainly within two silicified sections of the ore-zone, each about 500 or 600 ft. long, and with a gap of roughly 600 ft. between them.

High-grade ore from the B.C. Silver Mines, assaying 51 oz. of gold and 240 oz. of silver per ton, has been examined by Victor Dolmage (*Canad. Min. Journ.*, July 25, 1924, p. 711). The ore was found to consist of pale yellow pyrite, galena, blende, native silver (probably primary) and an unidentified sulphide (argentite ?) in a gangue of sericite and quartz darkened by finely disseminated galena, native silver blende and other sulphides. The ore differs from that of the Premier in not having any tetrahedrite, chalcopyrite, stephanite or polybasite, and in the absence of secondary enrichment.

The silver district of Cobalt, Ontario, is described in the Imperial Institute Monographs, *Silver Ores* (1921, p. 44) and *Cobalt Ores* (1924, p. 23), as well as in this BULLETIN (1922, **20**, p. 389). An article by Arthur A. Cole (*Eng. and Min. Journ.-Press*, Aug. 30, 1924, p. 325) gives an account of some of the later developments at Cobalt.

The Nipissing still continues to be the largest silver shipper in Cobalt, the output for 1923 being estimated at 3,397,000 oz. About 300,000 lb. of cobalt was also produced, to be shipped this year. A new find was made late in 1923 at shaft No. 26 on the 100-ft. level in Keewatin formation a short distance below the lower contact of the diabase (dolerite) sill. This will average 1,000 oz. of silver per ton over an average width of 2 in.

The old Colonial mine was acquired by the Menago Mining Co. in July, 1922, and the shaft was sunk through the dolerite until the lower contact with Keewatin greenstone was reached at a depth of 970 ft. High-grade ore was encountered in the 930-foot level early in November, 1923. A shipment of 11 tons was made, and in addition to the steady accumulation of a small amount of high-grade ore, daily shipments of from 50 to 60 tons of mill

rock are being sent to the Cobalt reduction plant for treatment.

Most of the Beaver production came from the upper contact, but a shaft was sunk through the dolerite sill, and a small quantity of ore was found on the lower contact. This is now being further prospected.

The latest producer at Cobalt is the Genesee. The mine is on the southern boundary of the township of Bucke, about half a mile from the nearest producer. The company started operations in January, 1916, and in August, 1922, a 1-in. vein was encountered at the 350-ft. level. One year later the second vein was encountered, from 2 to 5 in. wide, and assaying 1,000 to 5,000 oz. of silver per ton. Some ore has been already shipped.

From 1904 to 1923, inclusive, Cobalt produced 325,685,112 oz. of silver. The highest output was in 1911, with 29,989,903 oz. In the years 1921, 1922 and 1923 the estimated output was 7,692,964, 7,593,272 and 7,320,000 oz. respectively.

Australia.—The silver-lead deposits of the Waratah District, Tasmania, have been reported on by P. B. Nye, Government Geologist (*Tasmania Dept. Mines, Geol. Survey, Bull.* 33, 1923). Although the district is famous for its tin and osmiridium deposits, the production of silver-lead ores has been disappointing. The Magnet mine has been the largest producer, and has prospects of a successful future; a small output is being produced by the Mt. Wright mine, and prospecting work is being carried out in the Godkin mine. All other mines are idle.

The oldest sediments are of Cambro-Ordovician age. The Dundas series of slates, cherts and breccias of igneous material are in faulted relation with the younger Bischoff series of black slates, sandstones and quartzites. In the western portion, shales, friable sandstones and limestones of Silurian age crop out. These three formations have been folded and faulted and intruded by igneous rocks of Devonian age varying from ultrabasic to acidic, and including peridotites, pyroxenites, gabbros, syenite, granite and porphyries. Typical dolerite ("diabase") of Upper Mesozoic age is intrusive into the above formations at several localities, and Tertiary sediments up to 100 ft. in thickness overlie them. The ore-deposits are silver-lead and copper. The former contain argentiferous galena (1 to 2 oz. of silver per unit of lead), blende and pyrite, the gangue being carbonates (*e.g.* mangano-siderite and ankerite), and quartz. The deposits are

genetically associated with the intrusion of igneous magma which occurred at the close of the Silurian period.

In the Magnet mine, the lode occurs within the Magnet dyke (Devonian), intrusive into the slates, cherts and breccias of the Dundas series. This dyke is 20 chains wide at the mine, and the section flows from E. to W. are approximately: websterite-porphyrite 360 ft.; "diabase"-porphyrite with associated variolite, 440 ft.; and bronzitite or websterite-porphyrite, 400 ft. The dyke contains two bodies of slate and sandstones of the Bischoff series. From surface to some depth the lode occurs at the hanging-wall of the websterite-porphyrites and near the junction of the latter with "diabase"-porphyrite. From No. 9 to No. 14 levels the whole "country" between the walls is mineralised, and consists of websterite-porphyrite almost completely replaced by white ankerite ("dolomite"), and often stained green by a chromium mineral. The largest and most important ore-body occurs on the footwall, but narrow veins and smaller bunches of ore occur throughout the lode. The lode has been followed down to 1,000 ft. from the outcrop and shows signs of continuing in depth. Reserves of first- and second-class ore exist above the bottom level, and a weekly production of 70 tons of crude ore and 30 tons of concentrate is being maintained.

The total production of the Magnet mine amounts to 143,750 tons of ore, containing 25,937 tons of lead and 5,923,711 oz. of silver, the net value of these being £1,277,079. Investigations are now in progress to save the zinc content of the ore, which is approximately 40 per cent. of the lead content.

Nye suggests that prospecting should be continued, especially in the area of basic and ultrabasic Devonian rocks, as these rocks were readily attacked by the mineralising solutions, and the majority of the lodes were formed in them.

Tin

Federated Malay States.—The Rahman tin mines of the Federated Malay States are described by Ernest F. Harris (*Chem. Eng. and Min. Review*, May 5, 1924, p. 297). Rahman lies 70 miles due east of Penang. The mines are located on a mountain of schist, over 2,000 ft. in height, with granite exposed in two places in the lower portions. The whole mountain is traversed by E.–W. tin-bearing quartz veins, mostly as small stringers, but up to 5 ft. in width in places. These veins or stringers are enriched by a series of N.–S. zones or fault channels,

four of which have been or are being developed. At the contact, solid bodies of cassiterite up to 5 ft. have been met. These crush up to 47 per cent. of tin oxide. The whole mountain is tin-bearing, and is being quarried from the 1,700 ft. contour to the top of Gunong Paku (2,090 ft. above sea level), and about 5,000,000 tons of ore have already been extracted and milled. The continuity of the deposit has been proved to 250 ft. below the 1,700 ft. contour. The whole material raised is being milled, and a tonnage of 68,000,000 tons is available above the 1,700 ft. contour. A new plant is being erected, the first unit of which will have a capacity of 2,000 tons a day. A 2,000 h.p. hydro-electric plant is being installed. When the new mill is in operation the output is expected to be 150 tons of concentrate (cassiterite) per month. During the last twelve-monthly period the gross output was 879 tons.

The Rahman mines are said to have been worked for well over 200 years, and to have produced 70,000 tons of tin.

British Honduras.—According to William R. Jones (*Mining Mag.*, Oct. 1924, p. 206), L. H. Ower, Government Geologist to British Honduras, in 1923 discovered cassiterite in concentrates from the stream bed of Stann Creek, but a much more promising area is that near the granite outcrop of the Vaca Pine Ridge, considerably to the west of the former. Below the point where the streams enter the gorge of the Belize River, extensive alluvial deposits have accumulated, and concentrates carrying cassiterite and colours of gold have been obtained from the river-beds and from the river-banks. The tinstone is associated with molybdenite and tourmaline. Ower is of opinion that some of these deposits may be found to carry workable quantities of cassiterite. He also thinks that the Cockscomb area, S.E. of the Vaca Pine Ridge, is well worth prospecting, as both the South Stann Creek and Swasey stream, before leaving the granite country through the slate gorges, have here formed extensive alluvial deposits.

The above would appear to be, in reality, a re-discovery, for on the geological map published with the present article " Estano Hill " is marked in the N.W. portion of the Stann Creek granite ; this is evidently meant for *estaño*, Spanish for tin, and Stann is clearly an anglicised form of the same word. It looks as if the Spanish-speaking inhabitants of British Honduras had long ago discovered tinstone *in situ* in that locality.

Australia.—The tin deposits of Mt. Bischoff, Tasmania, which occur in rocks of Cambro-Ordovician age and are genetically connected with dykes of Devonian age, were briefly described in the Imperial Institute Monograph, *Tin Ores* (1919, p. 71), and Weston-Dunn's paper on these deposits has already been noticed in this BULLETIN (1922, 20, p. 403). A detailed report on the Mt. Bischoff tinfield by A. McIntosh Reid, Government Geologist, has appeared recently (*Tasmania Dept., Mines, Geol. Survey, Bull.* 34, 1923).

With regard to the properties of the Mt. Bischoff Tin Mining Co., McIntosh concludes that the lodes, which are large and irregular, are mainly replacement bodies after dolomite and not porphyry, as previously stated, and that the base of all of them is dolomite. As a rule, replacement took place along horizontal fractures in the rock producing the layered deposits, giving rise to the idea that the layers of replaced material represented beds of alluvium. Any ore-bodies below the present working levels will prove to be of this character, but will not be extensive.

Below Brown Face (large open cut) is a peculiar body of compact quartz sand, which contains a little fluorine and is seamed with thin threads of cassiterite. This section should be investigated.

Gossan Face body below the present level deserves attention, especially where the fault and lode fissures intersect. Flat " makes " will spread out from the main fissure here as elsewhere in the dolomite bodies. Although the end can be seen of all the large ore-bodies, the tin ore will continue in the smaller lodes and veins far below the base of existing workings.

More attention should be given to the veins. Although poor sections occur, rich shoots will probably be found to alternate with them. Some of these are 1 to 10 ft. wide, extend at surface for 2,000 ft. and more, and over 1,000 ft. on the dip.

The company possesses a big asset in its enormous deposits of marcasite and pyrite. This latter material contains 0·25 per cent. of free cassiterite, which could be separated by treatment in the concentrating plant. The sulphidic minerals might find a market, or the sulphides would have to be converted to marketable products at the mine. Although production has ceased for a time, development work is at present in progress on the properties.

Aplite dykes occur in the region in which cassiterite is invariably associated with lepidolite (lithia and fluorine-

bearing mica) in short, irregular lenses, usually crossing the dyke. These have been explored to a certain extent.

The Cleveland mine is on the western foothill of Magnet Range. The ore-bodies occur in strata of Cambro-Ordovician age, and are of two kinds—(1) Pyrrhotite-chalcopyrite deposits, which are irregular replacements of chert and tuff, extending from 20 to 30 ft. on both sides of the fissures. Many of the fissures, which are narrow and irregular, are filled with tin-bearing pyrite and quartz, and as a rule the fissure filling contains a greater proportion of tin than the replaced bodies. The mineral constituents of the lodes in order of quantitative importance are pyrrhotite, chalcopyrite, pyrite, quartz, arsenopyrite and cassiterite. Calcite is abundant. (2) Pyrite-quartz deposits; these ore-bodies are commercially the more important, not only because they contain as a rule a higher proportion of cassiterite, but because this class of ore is more readily oxidised, and the tin oxide it contains is thereby set free from the encasing pyrite. Quartz is the dominant mineral in these ore-bodies, and is followed in order of abundance by pyrite and cassiterite. Fluorspar and tourmaline are sporadic. The mine was worked by a company until 1914, and was then let on tribute until 1917, when operations ceased, largely owing to the collapse of the tin market.

Reid is of opinion that attention in future should be directed to the pyrite-quartz lodes. He considers the geological conditions to be decidedly favourable, and the prospects for the future success of the enterprise to have much improved.

The Mt. Bischoff tin field has produced tin ore to the value of £6,000,000, but only £100,000 worth of this was obtained from mines outside the small area enclosing Mt. Bischoff.

NOTICES OF RECENT LITERATURE

Zanzibar: An Account of its People, Industries and History. Pp. 84 + xx, 8 × 6½. (Zanzibar: The Local Committee of the British Empire Exhibition, 1924.)

Though merely two small islands off the African coast, Zanzibar and Pemba have played an important part in the colonial expansion of several Asiatic and European peoples. Their chequered history is well summarised in this Handbook, and may be usefully correlated by the reader with the section on the ethnology (including the

sociology) of the islands, the salient features of which are described in considerable detail.

The work provides an admirable survey of the subjects dealt with, concludes with a copious bibliography, and will serve as a standard account of the Protectorate and its industries.

ÉLÉMENTS D'AGRICULTURE COLONIALE : LES PLANTES À FIBRES. Par Yves Henry, Ingénieur agronome, Inspecteur Général de l'Agriculture aux Colonies. Pp. vi + 211, 7 × 4½. (Paris : Librairie Armand Colin, 1924.) Price 6 frs.

This little book on vegetable fibres is intended chiefly for the information of planters and administrators in the French Colonies. After a general introduction, in which the physical and chemical characters of fibres are briefly described, the author proceeds to consider various fibre plants and their products in the following order : cotton, kapok, ramie, jute, *Hibiscus* spp. and certain other jute-like fibres, sunn hemp, *Phormium tenax*, *Sansevieria* spp., *Agave* spp., *Furcræa* spp., *Musa* spp., and the coconut, raphia and piassava palms. It will be observed that flax (*Linum usitatissimum*) and hemp (*Cannabis sativa*) are not included and this may be due to the fact that they are not suitable for cultivation in the French Colonies. In any case, however, it is somewhat misleading to omit these very important plants from a list introduced by the following sentence : "Les principales plantes fournissant de la fibre sont les suivantes."

On the whole, the book has been carefully compiled, but in certain respects the information provided is by no means complete or up-to-date. As illustrations of this the following points may be mentioned.

In the section dealing with the varieties of cotton grown in Egypt (pp. 30–31) it is stated : "Mit Afifi. Elle est cultivée dans toute la basse Égypte, et, certaines années, produit près de 90% de la récolte entière de l'Égypte." "Sakellaridi. Variété nouvelle. . . . Semble être appelée au plus grand avenir." These passages would give the reader an erroneous impression since the facts are that of the total area devoted to cotton in Egypt during recent years the Mitafifi variety has occupied less than 0·5 per cent., and that from 75–80 per cent. of the total area has been planted with Sakellaridis (see this BULLETIN, 1924, **22**, 194).

In dealing with cotton pests (pp. 78–89) no reference is made to the pink boll-worm (*Gelechia gossypiella*) which has caused enormous damage in Egypt and else-

where during recent years, although both the less important American boll-worm (*Heliothis armiger*) and Egyptian boll-worm (*Earias insulana*) are described.

Sisal hemp is said to be cultivated in Yucatan, Florida, Bahamas, Hawaii, Mozambique and various parts of West Africa, but no allusion is made to the large areas now devoted to the crop in Kenya and Tanganyika.

GRUNDLAGEN DER RÖSTE. By Dr. Gerhard Ruschmann. Pp. x + 188, 8½ × 5¾. (Leipzig: Verlag von S. Hirzel, 1923.)

This work forms the first volume of a series on the investigation of fibres which is being issued under the editorship of Professor Dr. Friedrich Tobler.

After giving a general historical review of the subject of the retting of fibrous materials, the author discusses the conditions on which the process depends in relation to the botanical structure and chemical composition of the raw products. The various fungal and bacterial organisms are described which effect the decomposition of the middle lamella and thus free the fibres from their encrusting pectinous material. The different methods of retting, both natural and artificial, are considered in detail.

The book thus constitutes a complete monograph on the present knowledge of the subject, and is a useful and valuable contribution to the literature of vegetable fibres.

DIE FASERSTOFFE DES PFLANZENREICHES für Weberei, Seilerei, Flechterei, Papierfabrikation, für Binde-, Bürsten- und Stopfmaterial, mit ihren Namen in Ursprungsland, Handel und Wissenschaft. By Dr. Ernst Schilling. Pp. viii + 320, 9½ × 6. (Leipzig: Verlag von S. Hirzel, 1924.)

This work, which forms the second volume of the series "Bücherei der Faserforschung," edited by Dr. Friedrich Tobler, contains a list of fibres and fibre-yielding plants arranged alphabetically under their common, trade, vernacular, and systematic botanical names. The common, trade and vernacular names are followed in each case by the name of the country of origin of the plant and the botanical name. Under the botanical name are given the natural order, the common, native and commercial names, the country of origin, the part of the plant from which the fibre is derived, the principal uses to which it is applied and the principal literature in which it is described. It is of interest to observe that the most commonly occurring references are to Dodge's *Catalogue*

of the Useful Fibre Plants of the World, Watt's *Dictionary of the Economic Products of India*, Heyne's *Die nuttige Planten van Nederlandsch-Indië*, and the *Bulletin of the Imperial Institute*.

The list contains the names of nearly 2,000 plants, and a bibliography is appended comprising references to 460 publications.

The catalogue has evidently been compiled with much care and must have entailed a vast amount of labour, although, in the case of some of the fibres, important references have been omitted. Such a list of fibres and fibrous plants has been greatly needed and the work will be of immense service to all students of vegetable fibres as well as to technologists, importers and others.

THE AMERICAN LUMBER INDUSTRY. By N. C. Brown, B.A., M.F. Pp. xviii + 279, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 15*s*.

LUMBER: Its Manufacture and Distribution. By R. C. Bryant, F.E., M.A. Pp. xxi + 539, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1922.) Price 23*s*.

LOGGING: The Principles and General Methods of Operation in the United States. By R. C. Bryant, F.E., M.A. Second Edition. Pp. xiii + 556, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 23*s*.

These three books are intended for use as textbooks for courses in forest schools in the United States, and constitute valuable additions to the series of volumes dealing with the various aspects of American forestry which Messrs. Wiley & Sons have previously published. In the matter of illustrations and general style of production, the usual high standard of this firm has been maintained.

The American Lumber Industry embraces the principal features of the resources, distribution and utilisation of lumber in the United States, the author, who is Professor of Forest Utilisation in the New York State College of Forestry, being specially qualified to give a comprehensive survey of this vital industry. The book is designed to serve not only as a textbook in forest schools, but also as a practical aid for those engaged in the lumber industry and as a source of reference for the general public interested in national phases of the subject. The author has purposely abbreviated the chapters on sections of the

industry that have been dealt with fully in other books, such as logging, manufacture, preservation and seasoning, and has expanded those on which relatively little published material is available, such as the economics of the industry, statistics, and marketing methods. A short, select bibliography is provided of American works on logging, manufacture and distribution of lumber.

In the other two books special aspects of the lumber industry are treated in more detail. The subject matter of *Lumber* is divided into three parts. The first deals with plant location; the standard types of equipment used in the manufacture of lumber, and the methods of handling it at the sawmill plants. The second part treats primarily of the technique of the industry, including the methods of lumber manufacture, seasoning, products of the lumber trade, mill refuse and its disposal, and fire prevention and insurance. In the third part the economic problems of distribution are discussed and the activities of the lumber trade organisations of the United States reviewed. Various useful data, a bibliography, and a glossary of terms used in lumber manufacture and distribution, are given in an appendix. The glossary will be found very useful to readers outside the United States.

The rapid development in power logging machinery and methods during the ten years since *Logging* was first published, has necessitated much revision in preparing this second edition, and a chapter on the use of crawler tractors in logging work has been added by A. Koroleff, a Russian forest engineer, who has spent much time in studying the use of this kind of equipment in logging operations in the United States. The four parts into which the book is divided deal with (1) general matters, such as the forest resources of the United States and a summary of logging methods; (2) the preparation of logs for transport, including tools and equipment and methods of felling and log-making; (3) the transport of logs on land; and (4) water transport. At the end of each chapter is a list of books on the subject dealt with and these are all conveniently brought together again in an appendix. There is also a useful glossary of terms used in logging.

THE VEGETABLE PROTEINS. By Thomas B. Osborne, Ph.D., Sc.D. 2nd Edition. Pp. xiii + 154, 9¾ × 6. (London: Longmans, Green & Co., 1924.) Price 9*s*.

This valuable work is issued in the series of Monographs on *Biochemistry*, edited by R. H. Aders Plimmer, D.Sc., and F. G. Hopkins, M.A., M.B., D.Sc., F.R.S.

Since the publication of the first edition in 1911, such rapid progress has been made in biochemical science that the author has found it necessary to omit certain parts of the work, to introduce new chapters dealing with subjects which have recently become of importance, and to rewrite a considerable portion.

The basic and acid properties of proteins which were discussed in the earlier edition have since been the subject of extensive investigations, among which those of Professor L. J. Henderson, Ph.D., Sc.D., have been particularly prominent. At Dr. Osborne's request, a chapter on this branch of research has been contributed by Professor Henderson to the new edition.

The work deals fully with the occurrence, classification, characters and properties of the various vegetable proteins, and also with their nutritive value, and with some physiological relations of the vegetable proteins to the animal organism and the biological relations of seed proteins to one another. An excellent bibliography of the subject is appended.

The monograph has been very carefully compiled and forms a most useful work for all interested in this branch of biochemistry.

THE SIMPLE CARBOHYDRATES AND THE GLUCOSIDES. By E. F. Armstrong, D.Sc., Ph.D., F.R.S., F.I.C. Fourth edition. Pp. xi + 293, $9\frac{1}{2} \times 6$. (London: Longmans, Green & Co., 1924.) Price 16*s*.

The first edition of this monograph appeared in 1910, and the fact that three enlarged editions have since been published is evidence of the rapid development of this branch of chemistry. The most important new matter in this fourth edition is contained in a chapter which has been added on the constitution of the complex carbohydrates.

The arrangement of the first four chapters, which deal with the simple sugars and their derivatives, has been slightly altered. The sections dealing with stereoisomerism and isomeric change have been grouped together in a separate chapter, which is followed by a description of the principal di- and tri-saccharides and an account of their hydrolysis and synthesis by chemical means and by the action of enzymes.

A description of the chief natural and synthetic glucosides is given and the final chapter contains a brief survey of the functions of carbohydrates and glucosides in plants. This chapter contains fresh sections on the tannins and on recent work on the genesis of carbohydrates in wheat.

The book provides an excellent summary of the sub-

ject, whilst the extensive bibliography makes it of great value to all workers in this branch of chemistry.

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT. Revised by W. Harrison Martindale, Ph.D., F.C.S., and W. Wynn Westcott, M.B., Lond., D.P.H. Eighteenth Edition. Vol. I. Pp. xxxviii + 1163, $6\frac{1}{2} \times 4$. (London : H. K. Lewis & Co., Ltd., 1924.) Price *27s. 6d.*

In the preface to the new edition of this comprehensive compilation, a résumé is given of the directions in which advances have been made since the issue of the seventeenth edition in 1920 in connection with the introduction of new drugs and chemicals and new methods of employing older remedies.

The work deals not only with the enormous number of medicinal substances, both official and non-official, which the modern pharmacist has to handle, but also includes sections on vaccines and antitoxins, animal organotherapy, legislative enactments relating to poisons, and dangerous drugs and allied matters, and many other subjects.

The new edition contains all the useful features of the earlier issues and the work will continue to be an invaluable and indispensable book of reference for the druggist, dispenser and medical practitioner.

THE MICRO-ORGANISMS OF THE SOIL. By Sir E. John Russell, F.R.S., and members of the Biological Staff of the Rothamsted Experimental Station. Pp. vii + 188, $8\frac{3}{4} \times 5\frac{3}{4}$. (London : Longmans, Green & Co., 1923.) Price *7s. 6d.*

Rothamsted will earn the thanks of many workers for rendering accessible in so convenient a form the authoritative surveys of the biological aspects of soil science which constituted the lectures delivered by members of the Rothamsted staff at University College, London, under the auspices of the Botanical Board of Studies of the University of London. The book has been published as one of the Rothamsted Monographs on Agricultural Science and will form a useful introduction to fuller volumes dealing with the subjects of certain of the chapters which are promised in the "Monograph" series. Sir John Russell in an opening chapter gives an account of the development of the idea of a population of soil organisms, which indicates the important part played by Rothamsted in recent work on the subject, and, incidentally, illustrates the value of that "team work" which is essential in conducting researches in a problem embracing several departments of knowledge. This chapter forms an intro-

duction and a key to the subsequent sections of the book. Mr. H. G. Thornton deals with the occurrence of bacteria in the soil and with the methods employed in studying them, and discusses their activities connected with the acquirement of energy and with the building up of bacterial protoplasm. The method of treatment of this subject is fresh and interesting. Mr. Cutler's account of the protozoa of the soil is essentially a modern story virtually opening with the work of Russell and Hutchinson at Rothamsted on "soil sickness" during the early part of the present century, and continued down to the present time by Cutler and others. This section renders available the illustrated results of work published in journals not readily accessible to all students. The idea of an economic significance of the lower algæ contained in the soil is also one of comparatively recent growth, and the present position of knowledge of this interesting line of work is dealt with by Dr. B. M. Bristol. Dr. W. B. Brierley gives a critical account of the work done on soil fungi which, although known to occur in all types of soil, have as yet presented such difficulties in the way of their practical investigation as to leave uncertain the full part played by them in soil economics, though work done during the present century has demonstrated the importance of their activities as agents in the destruction of cellulose and as ammonifiers.

Dr. A. D. Imms writes an interesting chapter on the practically new subject of the influence of the invertebrate fauna of the soil other than protozoa. His contribution has of necessity to be based essentially on observations carried out at Rothamsted in recent years, and, in view of the limited information available, his main object has been to suggest a line of work in animal ecology that calls for investigation on soils of varying types. The book concludes with a chapter by Sir John Russell on the chemical activities of the soil population and their relation to the growing plant. Not the least valuable feature of the book is the selected bibliographies accompanying the individual chapters.

Insecticides and Fungicides, Spraying and Dusting Equipment. By O. G. Anderson, Professor of Horticulture, Purdue University, and F. C. Roth, Instructor in Horticulture, Purdue University. Pp. xvi + 349, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1923.) Price 15s.

This manual serves a two-fold purpose. Firstly as a laboratory guide in the preparation of insecticides and fungicides,

and in the construction, selection, testing and operation of spraying and dusting equipment, and secondly as a text-book on spraying and allied subjects. It cannot be regarded as a complete treatise, since only the more commonly used preparations are dealt with, and some of the important newer materials, such as sodium fluoride, are not mentioned. Nevertheless, as far as the book goes, it will prove useful, particularly the first part in which separate laboratory exercises are devoted to the various stomach and contact poisons, fungicides, combination sprays, fumigants, spraying equipment, etc. The second part opens with chapters on the control of insects and of plant diseases, contributed respectively by Professor J. J. Davis, head of the Department of Entomology, Purdue University, and Dr. Max W. Gardner, Associate Botanist, Purdue Agricultural Experiment Station. Then follow descriptions of the different types of spraying machinery and accessories and dusting outfits, a discussion of dusting as a means of controlling insect pests and fungus diseases, notes on a number of miscellaneous matters relating to spraying, and finally practical hints on running a gas engine, the last-named being adapted from *Farmers' Bulletin* 1013, issued by the United States Department of Agriculture.

AGRICULTURAL PROGRESS: The Journal of the Agricultural Education Association, 1923. Pp. 118, 9½ × 6. (London: Ernest Benn, Ltd., 1924.) Price 5*s*.

There is every justification for the launching of this new periodical which promises to fill effectively a recognised gap in the agricultural literature of this country and to play a useful part in the development of agricultural education. The journal has been primarily designed to provide a medium for recording the transactions and proceedings of the Agricultural Education Association, whose membership is recruited chiefly from among the increasing numbers of professional workers in agricultural education and research. The publication is further intended to act as a means of communication between such workers, and to serve as a medium for the exchange of views of agricultural teachers concerning the professional methods of a branch of education which in this country is still young. A feature common in journals of this class, viz., a résumé of the progress of research, which will appear in future issues, should prove of great practical utility to workers who, from the nature of their duties, can have but little opportunity of following in the original

scientific journals the progress made in the specialised branches of science affecting agriculture.

In the present issue an important feature is a print of the Memorandum of Evidence prepared by a Committee of the Agricultural Education Association (under the chairmanship of Sir E. John Russell) which was submitted last year to the Tribunal of Investigation appointed to advise as to methods for achieving the prosperity of agriculture in this country. There are several original contributions (among which may be mentioned papers on Farm Book-Keeping, the Strain in Red Clover, and Pig-Keeping) together with papers read at the conferences of the Association in Aberystwyth and London, and abstracts of addresses delivered at a conference on the technique of teaching held at Aberystwyth, including a paper by Sir A. D. Hall on the Function of the College Course on Agriculture. There is also a record of the Proceedings of the Association and a useful list of bulletins and reports officially published by agricultural education authorities and institutions during 1922–3. The new journal promises to be of value to many workers outside the ranks of those for whom it is intended in the first instance.

Sands and Crushed Rocks. By A. B. Searle. Vol. I. Pp. xiv + 475, Vol. II. Pp. ix + 281, 8½ × 5¾. (London: Henry Frowde and Hodder & Stoughton, 1923.) Price 52*s.* 6*d.*, the two volumes.

At the outset the author announces that in this book "the term 'sand' is used to indicate any loose, detrital, granular material occurring in accumulations of various kinds as a result of atmospheric, aqueous, chemical, volcanic or organic action." It will thus be evident that the scope of the work is extremely wide, embracing as it does substances, both natural and artificial, which have often no greater affinities than similarity of grain size.

As an illustration of this, in the third chapter, which treats of the chief characteristics of various sands, paragraphs are devoted to substances of such diverse natures as alluvium, asphaltic sands, Bann clay, bole, boart, breeze, carbide sands, copper sand, corundum, diatomaceous earth, ganister, gem gravels, gold placers, loess, monazite sand, mud, puzzolana, pumice sand, quartzites, schists, siliceous sinter, soil, wad and wolfram deposits.

The introductory chapters of the first volume contain brief mention of the various classes of igneous rocks from which sands are derived, the processes by which they are degraded into sand and their subsequent aggregation into

beds. There is then an account of the distribution of sands throughout the geological systems, but this is limited to deposits in the British Isles. The third chapter has been referred to above ; it serves chiefly as a glossary of terms. Then follow chapters describing the physical and chemical characters of the minerals of which sands are composed, and the various methods of investigating, grading and testing sands for different purposes. The latter half of the volume treats of the methods by which commercial deposits of sands are exploited, and includes chapters on mining and quarrying, crushing and grinding, purification (including the concentration of heavy minerals), grading and storage, and packing.

The second volume is concerned with the application of sands to industry and is practically confined to quartz sands. It deals with the employment of sands in brick-making, concrete, cement, plasters, road construction and metallurgy ; as refractory materials ; in agriculture ; for filtration ; in chemical industry, pottery manufacture and glass-making; as abrasives and polishes ; and in explosives, etc.

It is difficult to find any justification for attempting to embrace such a variety of substances with so little in common in one work, and it would have been better if the author had confined his attention to quartz sands, with which variety he is evidently most familiar. The wide scope of the work, its unbalanced nature and abundance of repetition render it somewhat tedious and unattractive.

Report of the Empire Motor Fuels Committee embodying other Allied Researches. Pp. ix + 352, 8½ × 5½. (London : The Institution of Automobile Engineers, 1924.)

This work consists of four sections. The first is a paper by H. T. Tizard, M.A., and D. R. Pye, M.A., A.I.A.E., on " The Character of Various Fuels for Internal Combustion Engines. The Influences of Specific Heat and Dissociation of the Working Fluid," which formed the basis of the investigation carried out by H. R. Ricardo on " The Influence of Various Fuels on the Performance of Internal Combustion Engines " on behalf of the Asiatic Petroleum Co., Ltd., the results of which form the second section of the book.

The third section is occupied by the Report of the Empire Motor Fuels Committee which was appointed by the Imperial Motor Transport Council in 1920.

The fourth section is composed of the following notes : (1) " The Work of Midgley and Boyd on Detonation," by

A. E. Dunstan, D.Sc., F.I.C., and Stephen Card, B.Sc. (2) "Solubility Relations and Other Properties of Mixed Fuels," by W. R. Ormandy, D.Sc., F.I.C., and E. C. Craven, and (3) "Further Notes on Fuel Research," by H. R. Ricardo.

The Publication Committee regard the volume as a complete review of the subject of fuels for use in high-speed internal combustion engines, and express the view that it will be "of great technical and practical value, alike to automobile engineers, to the producers of motor fuels, and to those interested in alternative or supplementary fuels."

The work contains three plates and numerous diagrams.

BOOKS RECEIVED

CEYLON. Its History, People, Commerce, Industries and Resources. Compiled by Plâté, Ltd. Pp. 207 + 119 + 125, 8½ × 5½. (Colombo: Plâté, Ltd., 1924.)

THE ENGLISH-SPEAKING NATIONS. By G. W. Morris, M.A., and L. S. Wood, M.A. Pp. xx + 396, 7¼ × 4¾. (Oxford: The Clarendon Press, 1924.) Price 3*s*. 6*d*.

TOBACCO CULTURE WITH SPECIAL REFERENCE TO SOUTH AFRICAN CONDITIONS. By H. W. Taylor, B.Agr. Pp. 176, 8½ × 5½. (South Africa: Central News Agency, Limited; London: Gordon and Gotch, Ltd., 1924.) Price 25*s*.

COTTON IN SOUTH AFRICA. By W. H. Scherffius, M.Sc., and J. du P. Oosthuizen, M.Sc. Pp. 207, 8½ × 5½. (South Africa: Central News Agency, Limited; London: Gordon and Gotch, Ltd., 1924.) Price 21*s*.

COTTON-CELLULOSE: ITS CHEMISTRY AND TECHNOLOGY. By A. J. Hall, B.Sc., F.I.C., F.C.S. Pp. 228, 9¾ × 7¼. (London: Ernest Benn, Limited, 1924.) Price 30*s*.

MODERN CEREAL CHEMISTRY. By D. W. Kent-Jones, B.Sc.(Lond.), F.I.C. Pp. ix + 324, 8½ × 5½. (Liverpool: The Northern Publishing Co., Ltd., 1924.) Price 25*s*.

WATERPROOFING TEXTILE FABRICS. By Herbert P. Pearson, M.Sc. Pp. 112, 9 × 6. (New York: The Chemical Catalog Company, Inc., 1924.) Price $3.

RATS AND HOW TO DESTROY THEM. By Mark Hovell, F.R.C.S. Pp. xlii + 465, 8½ × 5½. (London: John Bale, Sons & Danielsson, Ltd., 1924.) Price 10*s*. 6*d*.

REGENERATION FROM A PHYSICO-CHEMICAL VIEWPOINT. By Jacques Loeb. Pp. ix + 143, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1924.) Price 10*s*.

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Botanical names and titles of books are printed in italics and authors' names in capitals